MEMOIRS

OF THE

NATIONAL MUSEUM OF VICTORIA

MELBOURNE

(World List abbrev. Mem. nat. Mus. Vict.)

No. 27

Issued 2nd November, 1966

J. McNALLY
DIRECTOR

Published by Order of the Trustees

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Foreword

This number of the Memoirs is devoted to a series of papers dealing with a five year survey of Port Phillip Bay, Victoria, the results of which are to be published in two sections. This first section contains historical, geological, hydrological, floral and faunal papers. The second section will consist of the remaining systematic papers and discussion on the ecological communities.

Prior to 1957, the fauna and flora of this Bay had not been systematically studied and in that year the National Museum of Victoria and the Fisheries and Wildlife Department commenced an ecological survey. The planning and supervision of the research work was the responsibility of Miss J. Hope Macpherson, Curator of Molluscs, National Museum, and Mr. D. D. Lynch, Superintendent of Marine Fisheries Management, Fisheries and Wildlife Department. The staffs of the two institutions were assisted throughout the survey by the Underwater Explorers and Photographers Club and the Marine Study Group of Victoria. This volunteer work force provided labour to help in the collecting and sorting of specimens and their contribution is gratefully acknowledged.

The increasing exploitation of Port Phillip Bay by commercial and amateur fishermen, the growing recreational interest of many of the public in marine zoology and the rapidly changing physical nature of the environment which is inevitably associated with industrial and urban development imposed a degree of urgency on the need for a study of the general ecology of the Bay at this point in time.

The two institutions have an individual and collective interest in a survey of this nature. A managed and controlled utilization of the marine resources requires a knowiedge of the resources in its environment. A qualitative survey of the invertebrate fauna and flora provides a more subtle and direct measure of the biological changes which accompany physical change than does chemical monitoring, although the latter is to be developed. The Museum has a direct interest in the raw data, the material collected and the living organisms in relation to their environment.

JOHN McNALLY,
Director, National Museum.

A. DUNBAVIN BUTCHER,
Director of Fisheries and Wildlife.

PORT PHILLIP SURVEY 1957–1963

PART I

Editor, J. Hope Macpherson, Curator of Molluscs, National Museum of Victoria

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PORT PHILLIP SURVEY 1957–1963.

INTRODUCTION.

By J. Hope Macpherson,

National Museum of Victoria.

*D. D. Lynch,**

Fisheries and Wildlife Department, Melbourne.

HISTORICAL BACKGROUND.

Port Phillip is the most important body of sheltered water in Victoria and probably in Southern Australia. Its importance is due to a number of factors.

I. Its large land-locked tidal area of 735 square miles.

II. Its shores, particularly to the north, are densely populated, this is not entirely due to its size but to the fertility of the surrounding land and to the good rainfall encouraging settlement.

III. It affords one of the few safe anchorages for big shipping on a long inhospitable coast.

IV. Its resources which are utilized by commercial and recreational interests.

Port Phillip was discovered on 5th January, 1802, by John Murray in the *Lady Nelson.* Murray named the bay Port King after Governor King who later renamed it Port Phillip.

Fears of Governor King that France intended to establish a colony somewhere in Australia and the favourable reports of Bass, Grant, Murray and Flinders led to the decision of the British Government to establish a penal colony at Port Phillip under the command of Lieutenant-Colonel David Collins.

In the meantime Governor King instructed Lieutenant Charles Robbins in H.M.S. *Cumberland* to make a detailed survey of Port Phillip. His party included Charles Grimes the Acting Surveyor General of N. S. Wales, and James Fleming, who were to report on the nature of the country explored. The *Cumberland* sailed from Sydney on 23rd November, 1802, entering Port Phillip on 20th January, 1803, after a prolonged call at King Island. Grimes and Fleming's report (Grimes 1803 and Shillinglaw 1876) was sent to England but before its arrival, Collins had sailed in H.M.S. *Calcutta* on 27th April, 1803, and reached Port Phillip on the 9th October of the same year. Lieutenant Governor Collins considered the place unsuitable for settlement and in January, 1804 removed the entire establishment to Hobart. During the *Calcutta's*

* Present address: Inland Fisheries Commission, Tasmania.

stay J. H. Tuckey the First mate, and Deputy-Surveyor G. P. Harris, made a survey of the area, Harris's report of the country was unfavourable (Harris, 1803). After his return to England, Tuckey published an account of the expedition (Tuckey, 1805).

Permanent settlement was established under the leadership of John Batman in 1834.

From this date the settlement spread and the population in the bayside districts increased rapidly to almost 1,900,000 in 1959 when Melbourne and Geelong with 1,770,000 and 88,000 inhabitants respectively were the main centres.

TOPOGRAPHY.*

The general topography of Port Phillip Bay is shown in the Admiralty Chart No. 1171. (Chart 1 back of volume.)

The entrance to the bay is restricted in depth by two rocky banks of dune limestone. The 600 feet wide main shipping channel passes over the outer Rip Bank and the inner Nepean Bank. This channel has been deepened by blasting, over the past 60 years, from a least depth of 30 feet to its present declared minimum depth of 48 feet.

Between the two rocky banks lies a gorge with depths exceeding 300 feet, while south of Rip Bank the depths increase to approximately 90 feet 1 mile offshore.

The strong tidal flow through the very irregular constricted entrance produces the race, which is known as "The Rip".

TIDES AND TIDAL STREAMS.*

Owing to the narrow entrance and the large area of Port Phillip Bay, the range of tides within the bay is small in comparison with that at the entrance. Although tidal ranges exceeding 5½ feet do occur at Port Phillip Heads, the mean range normally varies from approximately 2½ feet to 3½ feet. At the northern end of the bay the tidal range normally varies from 1¼ feet to 2 feet.

The in-coming flood tide streams through the entrance from the south and east. At high tide, under normal conditions, the flood tide may reach a maximum of about 6 knots as it passes through the Heads. It then turns and spreads out towards Shortland Bluff and Point King, before passing through the sand banks with diminished strength.

The out-going ebb tide sets towards the bight between Point Lonsdale and Shortland Bluff, and then out through the entrance and away south-eastward along the shore. Slack water occurs near mid-tide when the levels inside and outside the Heads are the same.

Extreme weather conditions can cause the level in the bay to be raised or lowered, and thus change the strength and duration of the tidal streams.

* Extract of information supplied by Ports and Harbours branch of Public Works Department, Victoria.

HISTORY OF THE SURVEY.

The need for a biological survey of this important body of water was recognized quite early in the history of settlement and on 14th July, 1888, the Council of the Royal Society of Victoria elected a Committee of its most eminent scientists to direct the task. This Committee was instructed to arrange and carry out a systematic biological survey of Port Phillip and were allotted a grant of £50 to commence the work. The first report of this Committee for 1889 was published in Proc. roy Soc. Vict., 1890, together with a short account of the Crinoids by P. H. Carpenter and Alcyonaria and Zoantharia by S. J. Hickson. It also stated that other reports had been presented through the year and that Dr. J. Bracebridge Wilson had established a small Biological Laboratory and Aquarium at Sorrento. The Annual Report of the Royal Society for 1890 gave a detailed account of the committee's activities and mention was made of work on Hydrozoa by Professor W. Baldwin Spencer; Sponges by Dr. A. Dendy; Algae by Professor Agardh and a shark and *Argonauta* were recorded.

The 1892 committee report showed progress in the identification of material by specialists and the Royal Society Annual Report recorded the publication of a Monograph of Victorian Sponges Part I. but commented on the difficulty in getting specimens in other groups identified. Also it expressed appreciation of J. B. Wilson on whom sole responsibility for the collecting seemed to fall.

The report of the committee for 1894 again showed some progress but recorded difficulty in getting identifications of Tunicata, Polycheata and Pycnogonida. The Mollusca were to be incorporated in a general catalogue for Victoria being compiled by E. R. Pritchard.

The 1895 report again records progress but notes with regret the death of J. B. Wilson and therefore the cessation of collecting activities.

The 1896 report shows little further progress apart from work in hand and after this date mention of the Port Phillip survey and its committee lapsed.

With the death of Wilson the survey suffered a mortal blow as the large collections were almost entirely due to his activities. He had spent all his vacations in his yacht dredging within Port Phillip and along the adjacent coast. In spite of this the only stations adequately worked at the time of his death (Wilson, 1895) were round Port Phillip Heads. The much larger area of sheltered water within the bay remained unknown, its inhabitants to be discovered only at the whim of spasmodic itinerant collectors.

This was still more or less the state of knowledge of the biology of Port Phillip when the present survey was undertaken as a joint project by the Fisheries and Wildlife Department and the National Museum in 1957. To sum up this knowledge it could be said that a certain number of plants and animals had been recorded from Port Phillip but their distribution or numbers within the area were not known nor if the list was exhaustive.

The aim of the present survey was to record the macro flora and fauna and to plot its distribution and where possible at least make an assessment of the density of the populations present. In such a large area it was not possible to even attempt detailed quantitative investigation.

METHODS OF COLLECTING.

When the survey was initiated it was decided to carry out the investigation by direct observation and collecting with the aid of skin divers from the Underwater Explorers and Photographers' Club. This proved very satisfactory in reefy ground where it was impossible to use a dredge or grapple. In areas of sand or mud the preliminary investigation by divers was supplemented by dredge runs.

Also an underwater sledge, manned by a diver, was developed to make rapid preliminary examination of the bottom. The sledge was towed at a speed of about 1 knot behind the research launch and by manipulating hand controls a diver could regulate the distance of the sledge above the bottom. A series of bell signals allowed the diver to send simple direct messages to the crew of the launch. This method prevented the time-consuming effort of sending divers down on relatively barren ground and aided the quick mapping of large uniform areas such as *Zostera* beds.

If possible at least two divers examined each station and made separate collections. On return to the launch they were interrogated separately from a standard set of questions and their answers recorded on individual sheets. This procedure helped to remove any personal bias from the observations and collections made and allowed the data to be re-checked at any time.

Samples of bottom sediments and representative collections of all flora and fauna were kept from each locality. Members of the Marine Study Group of Victoria assisted in sorting and making preliminary separation into species. When the collecting for the day was completed all, except the very common and therefore well known species were preserved for examination and submission to a specialist in each particular group.

The fixing of stations was facilitated by the division of the Admiralty Chart No. 1171 into areas by means of a grid of 4′ of latitude by 4′ of longitude using 38° S and 145° E as base references. Commencing at the north-west corner of the chart the squares of the grid were numbered in running sequence as Areas 1 to 70 (Chart 1 back of volume). As convenient each section of the grid was visited until all areas had been covered. In this way it was possible to make an extensive coverage and to get an indication of the pattern of distribution of the flora and fauna. In actual fact it was not found necessary to work many stations within the 10 fathom line as this is a comparatively barren basin with either a mud or sandy mud bottom and a limited uniform population over large areas. After the initial diving and sledge runs to determine its limits it was found more practical to sample it by a series of spaced dredge runs.

Each dive or dredge position was given a station number (Chart 2 back of volume) and in the text a locality is recorded as an Area number followed by the station number in brackets, i.e., Area 23 (1). Table A back of volume records Area, station number, date, method of collecting (dive or dredge) and depth in fathoms.

An "Inshore Ferrograph" calibrated to 100 feet was used to fix the depths at the various stations.

ACKNOWLEDGMENTS.

We wish to acknowledge the help of members of the two groups, The Underwater Explorers' Club and the Marine Study Group who assisted in collecting and sorting. Special thanks are due to Mr. P. Webster and Mr. L. Bismire, Presidents of the former club, and Mr. P. Hollis, liaison officer for the club and to Mr. W. E. A. Nielson and Sir Robert Blackwood of the Marine Study Group for their constant help in sorting.

To Mr. J. Morris, Mr. R. Schoull, Mr. D. Puffett and Mr. J. Gresick of the Fisheries and Wildlife Department for their running of the Fisheries and Wildlife research vessel *Caprella* and for their help in innumerable ways towards the success of the collecting. A special thanks is due to Mr. Puffett for giving us the benefit of his detailed knowledge of the western and southern sections of Port Phillip.

It was realized at the beginning of the survey that the authors could not hope to handle satisfactorily the wide range of plants and animals which would be collected, so the co-operation of a number of specialists was sought and the following people have helped with identifications. A number of them have or will contribute separate systematic papers on their special study. We wish to acknowledge the help of Dr. Federick Bayer, Gorgonia; Dr. P. R. Bergquist,* Porifera; Mr. J. Bowler,* Geology; Dr. C. E. Cutress,* Actinaria; Dr. D. F. Squires,* Scleractinia; Dr. P. M. Ralph,* Hydrozoa; Professor George Knox,* Annelida; Professor W. Stephenson, Mr. Frank McNeil, Brachyura; Dr. W. Williams,* Amphipoda; Dr. E. Naylor,* Isopoda; Dr. John Yaldwyn* and Dr. A. A. Racek,* Crustacea (paper encompassing groups not listed separately); Miss E. Pope,* Cirripedia; Dr. R. Endean, Miss Ailsa Clark,* Echinodermata; Dr. R. H. Miller,* Ascidians; Dr. A. Vigeland,* Bryozoa; and Dr. H. B. G. Womersley,* Algae; Dr. A. W. Beasley,* Bottom sediments, Mr. J. Willis,* Flora and Marine Angiosperms of the Port Phillip area; Dr. David Rocheford,* Hydrology; Mr. J. Fryer,* Tides and Tidal Streams; Dr. R. Southcott,* Medusae; Dr. Huzio Utinomi,* Octocorals; Dr. S. Edmonds,* Sipunculidae and Echuroidea.

The present volume contains papers from only some of those listed above as authors. Due to previous commitments or the volume and nature of the material resulting from the survey, some authors have not been able to complete papers in time for this initial volume. These will be published at a later date when the remainder of the material has been worked together with detailed discussion on the communities present.

Finally thanks to all those "other" persons in both departments who have from time to time contributed in their various fields and in particular to Mrs. N. Wortley, who typed most of the manuscripts, Miss P. Hoggart, assistant in Conchology and Mr. J. Mooney, assistant in Mineralogy, all of the National Museum.

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Footnote: *Making a written contribution.

PORT PHILLIP SURVEY 1957–1963.

THE FISHERIES.

By *D. D. LYNCH.*

*Fisheries and Wildlife Department, Victoria.**

SUMMARY.

The history of commercial fishing in Port Phillip is outlined and the quantity and value of catches of the various species is tabulated.

INTRODUCTION.

The physiography of Port Phillip Bay has an important bearing on the extent and scope of its fisheries. Although the area of the Bay is 735 square miles, approximately one quarter of it is over 10 fathoms in depth and here the bottom consists of mud with a limited fauna, which is dominated by small Echinoderms. The sand banks in the shallows and the channels provide the more productive commercial fishing grounds for scale fish. Here, and to a less extent on reefs, line and net gear are used.

Fishing probably started as soon as the early settlers arrived in order to provide the colony with a varied diet. The first formal collection and tabulation of fisheries statistics in Victoria was not attempted until 1903 when the total fish catch at a number of centres was recorded. From 1911 more detailed collections and tabulations were made to show the fish catch by species, the port of landing and the number of licensed fishermen. For the purpose of this account it is sufficient to consider the statistics for the decade 1951–60.

Table 1 shows that the annual fish catch excluding oysters for Port Phillip Bay between 1951 and 1960 ranged from just over 1½ million lb. to just over 2¼ million lb. annually. The catch listed separately for Queenscliff is made up of fish caught inside the Bay as well as flathead and barracouta which may be taken up to ten miles outside The Heads. The catches of crayfish and school shark which are taken in Bass Strait and Tasmanian waters by boats operating from Queenscliff are not included in this table.

The table shows that the fish catch for Port Phillip Bay proper has been stable over the last decade.

* Present address: Inland Fisheries Commission, Tasmania.

TABLE I.

FISH CATCH FOR QUEENSCLIFF AND REMAINING PORTS OF PORT PHILLIP BAY 1951–1960

Year	Queenscliff Catch in lb	Remaining Ports Catch in lb	Total Catch in lb
1951	693,000	1,401,000	2,094,000
1952	810,000	1,317,000	2,127,000
1953	946,000	1,315,000	2,261,000
1954	914,000	1,434,000	2,348,000
1955	529,000	1,138,000	1,667,000
1956	364,000	1,354,000	1,718,000
1957	449,000	1,567,000	2,016,000
1958	446,000	1,328,000	1,774,000
1959	635,000	1,267,000	1,902,000
1960	784,000	1,564,000	2,348,000

ORGANIZATION OF THE FISHERY.

Fishing licences were issued free until 1913 when a fee of 2s. 6d. was introduced. Subsequent increases in licence fees were, in 1918 to 5s. in 1930 to 10s. and in 1949 to £2. The early increase in fishing licence fees did not have much effect on the number of licences issued and, as many licence holders were either part time or amateur fishermen, not a great deal of confidence can be placed on the earlier records in determining the importance of the Port Phillip Bay fishery in the economy of the settlement.

Since 1950 only full time professional fishermen, i.e., fishermen who obtain a substantial part of their income from fishing, have been licensed to catch fish for sale. From 1950 and 1959 the number of professionals varied from 295 to 268 whereas in 1948 and 1949 the number of fishing licences issued for persons operating in Port Phillip Bay was 643 and 639 respectively. However less than half of these licence holders carried on fishing as a full time occupation.

The early development of the Port Phillip fisheries was limited to some extent by the absence of suitable facilities for transporting the catch to Melbourne. Before the advent of railways the fish landed at ports such as Sorrento, Queenscliff, Mornington, St. Leonards, Portarlington and Geelong came to Melbourne by boat. To-day nearly all fish come to market by road transport. Traditionally the catch off the Bellarine Peninsula supplied Geelong, primarily, and the surplus, if any, was sent to Melbourne.

The Victorian fish marketing system is a free one whereby fishermen may dispose of their catch by private treaty or by public auction. A fishmarket in Melbourne has a number of agents who simultaneously sell fish on behalf of fishermen. For many years these agents assisted the development of the industry by providing capital to fishermen for the purpose of purchasing boats and gear.

In 1960 the fishing fleet consisted of 229 boats which the fishermen valued at £268,433 and the fishing gear was valued at £53,251. The details of the distribution of the boats and gear by value are shown in Table II. On the basis of investment in boats Williamstown, Queenscliff and Port Melbourne are the most important fishing ports. Geelong, having a small boat fishery, is second to Queenscliff as the base with the largest number of boats and fishermen.

TABLE II.

DETAILS OF VARIOUS PORTS SHOWING THE NUMBER OF BOATS, THEIR VALUE, THE VALUE OF FISHING GEAR AND THE NUMBER OF FISHERMEN IN 1960.

Port	Number of Boats	Value of Boats and Tenders	Value of Gear.	Number of Men.
		£	£	
Black Rock	8	5,774	915	7
Chelsea-Carrum	6	1,930	3,995	8
Dromana-Rosebud	13	15,545	1,265	14
Frankston	10	3,105	1,150	14
Geelong	27	14,850	7,745	40
Mordialloc	10	10,960	4,986	16
Mornington	12	3,717	1,360	14
Portarlington	14	10,120	4,160	19
Port Melbourne	12	32,850	4,064	23
Queenscliff	36	63,210	4,700	49
Sorrento	24	20,220	4,641	46
St. Kilda	12	6,365	5,205	18
St. Leonards	16	10,980	3,050	22
Werribee	9	4,200	1,960	16
Williamstown	20	64,607	4,070	29
Total ..	229	268,433	53,251	335

BOATS.

The grounds are sufficiently close to the home ports for fishing operations to be followed on a daily schedule. The boats in the various fisheries are of simple design and range in size from 20 to 30 feet overall in length. The smaller boats are powered by petrol driven engines and those over 30 feet are diesel powered. Until the mid nineteen twenties the sail was the usual method of propulsion for fishing vessels operating in Port Phillip Bay.

The larger vessels operate in waters outside the Bay and land the catch at their home port or at Melbourne. These boats carry echo-sounders, two-way wireless, refrigeration or fish well and make trips of several weeks' duration to Bass Strait. Most boats are multi-purpose in being suitable for using the fishing method appropriate for the season and species of fish accessible. The size analysis of the fishing fleet operating from the various ports in Port Phillip in 1960 is shown in Table III.

TABLE III.

SIZE ANALYSIS OF FISHING BOATS REGISTERED IN PORT PHILLIP BAY 1960.

Port.	Number of Boats of Various Length Groups.								
	10-20 feet.	20-25 feet.	25-30 feet.	30-35 feet.	35-40 feet.	40-45 feet.	45-50 feet.	50-55 feet.	Over 60 feet.
Black Rock	6	1	..	..	1				
Chelsea-Carrum	4	1	..	1	..				
Dromana-Rosebud	1	9	2	1	..				
Frankston	8	2	..	..					
Geelong	10	4	10	3					
Mordialloc	3	2	2	2	1				
Mornington	6	3	3	..	..				
Portarlington	1	9	4	..	..				
Port Melbourne	7	1	3	..	..				
Queenscliff	10	10	7	5	3	..	..		
Sorrento	12	8	2	1	..	1	..		
St. Kilda	5	1	4	2	..	..	..		
St. Leonards	6	8	2	..	..	..	..		
Werribee	4	2	3	..	..	..	..	..	..
Williamstown	8	1	2	2	1	..	3	1	2
Total ..	91	62	44	17	6	1	3	1	2

FISHING METHODS.

The species catch by weight for the decade 1951 to 1960 for Queenscliff and for the remaining ports of Port Phillip is set out in Tables IV. and V. respectively.

The fishing methods used in Port Phillip Bay are limited to the use of the simple traditional gears; trawling is not permitted. Hand lining is used to catch Snapper (*Chrysophrys auratus*, Cuvier and Valenciennes) migrating through the entrance; trolling is used for Snook (*Australuzza novaehollandiae* (Gunther)), and Barracouta (*Leionura atun* (Euphrasen)).

Fishermen from southern Europe introduced the long-line method for such species as Snapper, Rockling (*Genypterus blacodes* Bloch and Schneider) and Rock Cod (*Physiculus barbatus* (Gunther)), in the early nineteen twenties and this method, with a limitation on the number of hooks which a fisherman may use, is permitted only during the autumn and winter months.

The characteristics of long lines used to take Rockling are further regulated in that the construction material in the snoods, the type of bait and the maximum hook size are specified.

From late spring until autumn several types of beach seine nets are used to catch a number of species of fish and molluscs, namely Australian Salmon (*Arripis trutta* Foster) Snook, Sea Garfish (*Hemirhamphus melanochir* Valenciennes), Ruff (*Arripis georgianus* Cuvier and

TABLE IV.

ANNUAL CATCH OF FISH AND CRAYFISH IN LB. QUEENSCLIFF 1951–1960.

Species.	1951.	1952.	1953.	1954.	1955.	1956.	1957.	1958.	1959.	1960.
Anchovy	..	..	360	..	475	..	..	978	..	419
Australian salmon ..	42,986	116,998	66,329	39,806	21,156	47,139	18,166	12,070	19,964	39,322
Barracouta	439,985	528,029	686,065	623,032	359,312	230,166	314,618	305,448	477,925	633,244
Butterfish	..	19	63	642	410	..	615	132	142	188
Flathead, rock	..	..	..	..	340	297	615	..	..	679
Flathead, sand	2,621	4,746	22,880	29,504	16,011	18,716	6,458	10,257	3,791	54,529
Flounder	2,149	1,582	86	40	316	985	1,057	193	4	157
Garfish	10,319	9,315	7,402	3,283	6,084	5,589	5,817	3,435	3,935	8,843
Mullet, sea	..	..	..	..	..	..	..	..	..	..
Mullet, yellow-eye ..	5,866	2,061	4,233	5,677	2,498	8,868	5,703	2,035	4,057	8,617
Pilchard	..	..	..	..	..	70	..	..	..	1,759
Rock cod	2,698	1,819	178	2,700	206	31	44	..	1,514	1,978
Rock ling	65	..	65	132	7	80	..	6	303	153
Ruff	12,740	2,467	..	8,331	4,836	..	12,373	19,107	5,294	902
Shark, gummy	..	..	33	256	1,075	861	4,294	12,058	9,811	4,053
Shark, school	122,619	120,813	119,433	158,263	61,149	13,470	47,769	30,694	57,497	45,613
Snapper	20,129	13,276	16,313	9,851	5,757	8,038	7,612	12,511	17,186	19,949
Snook	2,019	2,151	5,213	1,113	1,313	426	2,696	2,326	3,305	4,852
Sprat, blue	..	..	1,000	..	..	..	..	2,400	180	629
Trevally, silver	560	1,312	395	263	28	210	..	4	..	44
Whiting, King George ..	1,203	1,505	1,214	652	5,383	1,653	1,915	525	70	469
Yellowtail kingfish ..	11,758	2,446	7,669	2,793	9,245	5,153	1,858	292	11,293	8,214
Mixed species	14,743	1,295	1,211	7,292	9,575	9,912	4,661	8,031	2,923	13,432
Annual Total ..	692,460	809,834	940,142	893,630	505,178	351,664	436,271	422,502	619,194	848,045
Crayfish	65,052	125,468	82,128	80,820	48,132	64,588	45,697	63,563	57,701	126,828

TABLE V.

ANNUAL CATCH OF FISH IN LB., PORT PHILLIP BAY EXCLUDING QUEENSCLIFF 1951–1960.

Species.	1951.	1952.	1953.	1954.	1955.	1956.	1957.	1958.	1959.	1960.
Anchovy	23,011	18,207	59,714	134,340	14,804	14,784	44,338	99,233	12,995	57,877
Australian salmon	320,132	254,418	202,342	258,152	146,037	185,712	163,370	306,909	148,833	200,183
Barracouta	27,515	41,205	41,504	65,629	62,836	60,650	50,076	21,955	61,941	47,751
Butterfish	2,297	3,272	8,123	10,211	13,738	13,347	16,217	12,805	10,289	5,721
Flathead, rock	1,252	887	311	350	7,952	6,914	9,402	12,787	11,601	30,751
Flathead, sand	340,037	313,140	420,606	364,987	388,433	360,707	325,372	306,000	284,690	277,891
Flounder	25,335	23,408	12,426	15,346	11,865	22,433	25,270	11,534	13,308	17,343
Garfish	132,979	139,046	127,132	172,981	65,582	148,577	106,891	56,515	66,001	81,094
Mullet, sea	5	472	962	1,611	2,944	4,593	1,671	2,628	3,152	2,429
Mullet, yellow-eye	30,305	64,508	95,129	44,956	30,164	29,544	30,729	69,912	30,931	32,300
Pilchard	102,384	77,021	9,750	40,255	122,122	159,204	7,785	26,343	176,412	324,705
Rock cod	9,067	29,813	20,400	32,526	25,418	21,206	17,353	9,059	11,181	29,215
Rock ling	2,584	391	8,511	27,466	17,560	6,182	3,747	5,648	4,694	2,356
Ruff	43,609	20,977	1,241	37,012	17,198	6,288	385,161	81,556	37,728	4,298
Shark, gummy	81,277	69,015	43,428	24,495	18,973	19,268	21,506	46,351	40,425	49,560
Shark, school	..	..	2,889	4,213	4,628	3,804	3,798	3,228	988	582
Snapper	133,081	175,291	183,155	112,671	146,548	77,720	71,136	77,430	93,301	94,315
Snook	23,519	30,434	51,762	32,100	14,998	128,467	106,788	51,234	65,497	101,196
Sprat, blue	19,420	10,342	25,026	18,406	27,404	18,141	26,394	30,551	41,896	53,855
Trevally, silver	15,722	29,124	7,949	5,179	9,078	7,293	30,168	7,732	5,884	10,686
Whiting, King George	44,365	46,966	26,994	8,265	26,641	63,503	22,016	28,832	46,596	45,563
Yellowtail kingfish	7,013	578	2,832	1,713	4,155	373	211	330	3,767	3,015
Mixed species	3,600	13,213	11,117	17,403	14,629	28,078	48,357	24,273	40,219	32,860
Annual Total	1,388,509	1,361,728	1,363,303	1,430,267	1,193,707	1,386,788	1,617,656	1,292,845	1,212,329	1,505,546

Valenciennes), Snapper, Silver Trevally (*Usacahanx nobilis* (Macleay)), King George Whiting (*Sillaginodes punctatus* Cuvier and Valenciennes), Leatherjackets (*Cantherines* spp.) Yelloweye Mullet (*Aldrichetta forsteri* (Valenciennes)), Yellowtail Kingfish (*Seriola grandis* (Castelnau)), Flounder (*Rhombosolea tarpirina* (Gunther)) and Squid (*Sepioteuthis australis* (Quoy and Gaimard)).

A modification of the beach seine gear has been evolved to catch snapper which are on sand or reef. The hauling ropes and the net itself are heavily buoyed with six gallon drums as floats enabling the gear to be lifted over reefs. The hauling ropes may be up to 1,000 yards in length and the net is pulled ashore by means of petrol driven winches mounted on the beach or in two boats at anchor. The efficiency of the gear is limited by strong tides or by a slight sea.

Three important mesh net fisheries operate during the winter and spring months; the first is for the Sand Flathead (*Trudis bassensis* Cuvier and Valenciennes), Longnose Flathead (*T. caeruleopunctata* (McCulloch)), and Rock Flathead (*Leviprora laevigata* (Cuvier and Valenciennes)); the second is for Flounder (*Rhombosolea tarpirina* (Gunther)); the third is for Gummy Shark (*Mustelus antarcticus* (Gunther)). Until recently fishermen limited the catch of the Sand Flathead because of buyer resistance to it, in the round. However, recently a fishermen's co-operative society stimulated the demand for this species by establishing a new market for the larger sized fish as frozen fillets.

A small fishery to supply the anglers bait trade existed for many years around Port Phillip; drop nets were used to catch the Pilchard (*Sardinops neopilchardus* (Steindachner)) and the Australian Anchovy (*Engraulis australis* (Shaw)). In the absence of a demand for these species for processing, more efficient gear such as the purse lampara net, has been used only to a limited extent since its introduction in 1950. In 1960 this disability was overcome when a Melbourne cannery offered to process large quantities of Pilchards. A 75 boat was rigged for purse seigning, with a suitable knotless nylon net, a puretic power block and powerful lamps.

Unfortunately after a few promising catches of several tons the venture failed, mainly for two reasons. The catches contained both Anchovy and Pilchard and the process of separating them proved costly. Secondly, it was found that on a number of occasions an operation showing prospects of success would be ruined when barracouta caused the schools to disperse. The temporary abundance of fresh Pilchards from this venture stimulated the demand for this fish from the New Australian settlers for use as food.

For many years the mollusc fisheries in Port Phillip were restricted to a portion of Geelong Outer Harbour where the Mud Oyster (*Ostrea angasi* (Sowerby)), is dredged in the winter months. Fishermen are limited by law to a catch of 30 bushels of Mud Oysters in any one week.

Originally the Squid caught in seine nets was utilized exclusively as bait by anglers and commercial fishermen. After 1945 the arrival of

migrants from southern Europe increased the demand for use as food to such an extent that over 100,000 lb. were caught in 1959 from Port Phillip Bay alone.

The Mussel (*Mytilus planulatus* Lamarck) also once only utilized as bait for anglers, is now taken in quantity and bottled for human consumption. Mussels are taken by scraping from piles or by diving on sand or mud. Dredging for Mussels proved unsatisfactory as the removal of sand from the animal is difficult.

Since 1959 small quantities of Haliotis or Abalone (*Schismotis leavigata* Donovan and *Notohaliotis ruber* Leach) which occur on the reefs mainly in the southern end of Port Phillip have been harvested by skin divers for canning.

THE SCALLOP FISHERY.

This fishery is considered separately here because of its recent origin and because of the influence the ecological survey had on its development and subsequent management.

In 1949–50 some trial dredgings for the Scallop (*Pecten alba* Tate) were carried out (Lynch 1963). More detailed information concerning the distribution of the scallop concentrations in terms of number per square yard for the various beds was obtained in the course of the survey proper. As this information was of interest to fishermen it was made available in the hope of encouraging the establishment of a small commercial fishery. The most promising beds awaiting development were indicated as occurring off Dromana, Point Cook, Portarlington, Williamstown and Rickets Point in depth from 7–10 fathoms. The yield of edible " meat " from the catch taken in the trial dredgings averaged 39 lb. per 1,000 scallops.

No formal legislation for gear specifications was recommended but fishermen were encouraged to use a dredge with a catching blade 4 feet wide. The undulating sea floor and the strong run of the tide made the use of heavier sled type dredges desirable.

In anticipation of the development of a fishery, a proclamation in 1960 declared the Scallop a fish for the purpose of the Fisheries Act.

Serious dredging for scallops on a full time basis in Port Phillip Bay commenced on 23rd September, 1963, when W. A. Donaldson began operations in his converted Danish seine trawler " Coldstream ". Donaldson used two sputnik dredges, the design of which incorporates sled type runners, a depressor plate which holds the dredge firmly on the bottom and allows it to be towed at a greater speed without lifting. It has adjustable teeth on the dredge blade.

The sputnik dredges became the standard equipment for the other fishermen entering the fishery in Port Phillip.

The rapid growth of the fishery is shown in Table VI. Both the number of boats in the fishery and the catch per month continues to rise.

TABLE VI.

NUMBER OF BOATS FISHING AND THE MONTHLY CATCH OF SCALLOPS IN PORT PHILLIP BAY TO JULY, 1964.

Month.	Number of Boats.	Production of "Meat" (lb.)
1963—		
September	2	1,941
October	19	69,219
November	29	135,769
December	33	148,135
1964—		
January	37	169,495
February	40	195,439
March	45	182,432
April	45	224,644
May	57	211,775
June	17	226,340
July	75	260,876

The value of the catch to fishermen up to July 1964, was approximately £265,000. The total value of this new fishery to the State of Victoria is considerably more than this as it provides employment in the fields of storage, transportation and processing.

The introduction of a Scallop fishery in Victoria posed a number of technological problems such as the provision of berth accommodation for the boats, the provision of transport, processing and storage facilities and, finally, the locating and development of home and overseas markets.

An important side effect of this new fishery on other commercial fisheries was the diversion of some boats and fishermen from the crayfish fishery. This is shown in Table VII. which indicates the length composition of boats which have fished for scallops in Port Phillip. The most common size groups are within the range 30–50 feet which is larger than that of the fleet engaged in other fishing within the Bay. Table III. shows that, in the latter, almost 90 per cent. of the registered boats were in the 10–30 feet group and less than 10 per cent. were in the 30–50 feet group.

TABLE VII.

BOAT LENGTH FREQUENCY IN THE PORT PHILLIP SCALLOP FISHERY TO JULY, 1964.

Boat Length.	15–20 feet.	20–25 feet.	25–30 feet.	30–35 feet.	35–40 feet.	40–45 feet.	45–50 feet.	50–55 feet.	55–60 feet.	60–65 feet.	65–70 feet.	70–75 feet.	75–80 feet.	80–85 feet.	85–90
Number	2	4	6	20	22	23	20	2	6	4	2	0	0	0	1

Tasmanian fishing boats and crews dominated the early stages of development but later Victorian boats and fishermen entered the fishery.

The Scallop fishery of Port Phillip Bay has several unique features. First, it commenced mainly as a result of information made available from Departmental trial dredgings and ecological investigation. Secondly, the fact that this investigation preceded the establishment of the fishery should facilitate later comparative studies with the objective of providing a monitoring service on the fishery. The collection of detailed catch and effort statistics commenced with the fishery and at the same time a weekly catch sampling programme was put into operation.

RECREATIONAL FISHERIES.

There are 143 nautical miles of foreshore around Port Phillip and much of it is used by the 1,900,000 bayside residents as well as by visitors from inland centres. Facilities provided by the Ports and Harbours Branch, Public Works Department, include a number of jetties. Hire boat proprietors cater for the fishing needs of the non boatowner. This service, together with the development of mobile lightweight trailer-borne craft and reliable high powered outboard engines, has increased the angler useage of Port Phillip. There is no saltwater fishing licence needed to fish in Victoria so a direct measure of the angling intensity in Port Phillip is difficult to obtain.

To obtain an estimate of the number of boats fishing in Port Phillip, an aerial census was carried out by three observers on the morning of Sunday, January 28, 1962. Figure 1 shows that on this morning 1,208 boats were fishing in Port Phillip Bay. Routine patrols by officers of the Fisheries and Wildlife Department confirm that this figure is usual for a pleasant weather angling weekend. Figure 1 shows that less than ·5 per cent. of the boats fished the central mud basin. The preferred localities were reefs, channels or sand banks.

By far the most sought after fish by anglers is the Snapper. It is accessible to anglers in greatest numbers between November and April. In respect to numbers and weight of fish taken by anglers, the Sand Flathead is the most important angling fish in Port Phillip Bay. It provides angling throughout the whole year. The King George Whiting, is angled in the shallower waters near Zostera beds from late spring until early autumn. The Sea Garfish, is angled from jetties around the Bay in the autumn.

The spearing of Flounder, and Longnose Flathead, is common on all sandy beaches particularly in autumn. Since 1955 underwater spear-fishing has become a very popular hobby off rocky headlands and on the shallow reefs. The main species of fish taken by this method are Butterfish (*Dactylophora nigricans* Richardson), Port Jackson Shark, (*Heterodontus portusjacksoni* (Meyer)), Marbled Kelp Fish (*Dactylopagrus arctidens* Richardson), and Longnose Flathead. Also divers using snorkel or self-contained apparatus collect edible shellfish.

FIG. 1—Distribution of fishing boats in Port Phillip Bay on 28th January, 1962.

To date the fisheries of Port Phillip have been managed to satisfy the somewhat conflicting needs of the recreational and commercial fishermen. To do this, compromise regulations, which are not ideally suited to either objective, have been necessary. However, while the substantial commercial fishery continues to operate and with recreational needs on the increase, it seems that the compromise method of management is the most suitable one at least in the forseeable future.

ACKNOWLEDGMENTS.

Fisheries and Wildlife Department, made available statistics relating to the scallop catch and the number of boats operating in the fishery from February to July, 1964.

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PORT PHILLIP SURVEY 1957–1963.

THE GEOLOGY AND GEOMORPHOLOGY.

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CONTENTS.

SUMMARY.

Port Phillip Bay lies in a tectonically controlled depression in which recurrent faulting has occurred from Palaeozoic to Recent time. Stratigraphic and geophysical evidence indicates maximum vertical displacement in the sunkland of more than 2,000 feet.

Variations in lithology and topographic relief affect the coastal landforms developed on the east and west. On the east coast, cliffs and shore platforms are more common than on the west; beaches are broader and off-shore bars are larger and more complex. Coastal sand ridges which are rarely developed on the east are common on the west.

The submarine geology has been studied from fathograms and underwater observations using aqualung equipment. Fifty cores were obtained in Recent marine sediments in the northern part of the bay. Many cores penetrated through Recent sediments to older deposits with a fossil soil horizon. The age of the marine transgression which flooded this horizon is estimated as approximately 8,000 years ago. Rates of Recent sedimentation on the buried surface of 0·4 to 1 foot per 1,000 years are indicated from sediment thickness.

The formation of the widespread aeolianite on the southern coast is reviewed, and evidence in favour of formation during periods of Pleistocene high sea level is proposed. Quaternary downwarping in the sunkland of approximately 400 feet is necessary to explain the continuation of the aeolianite in depth.

Evidence for a small late Quaternary emergence of the shores of Port Phillip Bay is discussed in the light of a mid-Recent fall in sea level claimed by many workers from widely separated areas on the Australian coast. The evidence favours emergence of less than 10 feet but is complicated by combined tectonic and eustatic effects.

The pattern of present coastal changes is described from observations on the eastern beaches during severe storms in July, 1964. Some of the sand eroded off beaches by northerly gales was deposited off-shore; the remainder was carried south by littoral drift. By February, 1965, the winter pattern was reversed with greatest sand accumulation on the northern end of beaches.

Small beaches on the east coast with limited quantities of sand are being depleted by natural and artificial processes. Their conservation requires urgent attention.

Wind statistics show a strong seasonal alternation in frequencies and velocities from winter northerlies to summer southerlies. Westerlies may occur throughout the year but easterlies are always weak and infrequent. This asymmetry in wind distribution partly controls the different landforms and sedimentation patterns between east coast and west. On the east coast, complex sediment movement is controlled by changes in wave patterns from the north, west and south. On the west coast, north-easterlies are weak, and stronger northerlies and north-westerlies are limited by short fetch; the dominance of southerly winds produces littoral drift from south to north.

A geomorphic sequence for the Port Phillip area is proposed, in which structural, lithological, tectonic, eustatic and climatic factors combine to produce a complex pattern of landforms and sedimentary features.

INTRODUCTION.

In the last 100 years since A. R. C. Selwyn, the first director of the Victorian Geological Survey, described the geology of the Mornington Peninsula in 1854, many workers have contributed to the geology of the Port Phillip region. Few, however, have devoted their studies specifically to Port Phillip Bay.

This paper brings together the work of others, reassesses some former concepts of the geology of Port Phillip Bay and points out some misconceptions.

New information is provided from work carried out by the author in recent years. This falls into three parts:—

1. Results are included from submarine coring operations in the northern part of Port Phillip Bay during 1963–64. Cores were obtained by diving to the sea floor and driving a weighted clear plastic butyrate coring tube into the bottom sediment. By using this method, core recovery averaging 60–70 per cent. depths of penetration was possible. Penetration depths were usually limited by sediment strength and the length of coring tube available. Coarse shelly sands were difficult to core but lengths up to 6 feet of medium to fine sands, silts and clays were recovered. Cores returned to the laboratory were cut into halves lengthways on a circular saw for further study.

Detailed core information has been obtained in collaboration with A. G. Link, whose assistance is gratefully acknowledged.

2. Through the co-operation of the Ports and Harbors Division, Public Works Department, and by using a boat chartered by the Department of Geology, University of Melbourne, continuous fathograms have been obtained on selected traverses both inside and outside the entrance to Port Phillip Bay. By providing a continuous graph of bottom topography, these supplement the detailed and accurate bathymetric charts from soundings carried out by Commander Cox in 1861–64. A reliable geomorphic interpretation of the topographic features is therefore possible.

3. A brief analysis of the present physical environment of Port Phillip Bay is made using wind data from recording stations in the area. In this way, observed geomorphic and sedimentary features on the coastline, including present sediment movement on beaches, can be related to directional variations in wave energy distribution.

This work provides a regional assessment of the geomorphic features and problems in Port Phillip Bay. As such, specifically local detail, when used, has not been treated exhaustively. Conclusive answers to many problems are often not possible, and where the evidence is still open, conclusive answers have not been attempted.

GEOLOGICAL STRUCTURE.

Port Phillip Bay on the South Central Victorian coast, is located in a tectonically controlled depression or sunkland, bounded by two major faults, Selwyn's Fault on the east and the Rowsley Fault on the west (Fig. 1).

Selwyn's Fault trends north-north-easterly with downthrow on the north-west, and controls the northern margin of the Mornington Peninsula horst. The south-eastern part of Port Phillip Bay occupies the fault-angle depression formed on the downthrown side of the fault which cuts across the Nepean Peninsula from near Cape Schanck to Dromana. It extends north towards Frankston, on the seaward side of the Mt. Martha and Mt. Eliza granodiorites (Keble, 1950; Thomas and Baragwanath, 1950). Palaeozoic rocks are sheared near the fault contact and Tertiary sediments are warped in the area. Continuation of seismic activity to recent time was established by an earthquake in 1932 with the epicentre near Mornington on the line of the fault (Holmes, 1933).

Fig. 1.—Locality diagram and structural map of Port Phillip Sunkland showing the major tectonic features of the area. (c.f. Plate II)

The Rowsley Fault which controls the western margin of the sunkland, commences 10 miles west of Geelong and continues north-north-easterly for approximately 30 miles to north of Bacchus Marsh. The uplifted western block, now being dissected by rejuvenated streams, forms the Brisbane Ranges which rise in places to 700 feet above the sunkland. These have accordant summit levels falling from 1,350 feet in the north to near 500 feet at the southern termination of the fault near Bannockburn (Fig. 1). Near Steiglitz and Anakie, a deep lateritic profile forms plateau remnants on interfluves which increase in width towards the south, corresponding to smaller displacement on the fault and less active dissection. This structure, like Selwyn's Fault, dates back to Palaeozoic times with periods of recurrent activity to Late Pleistocene and Recent.

FIG. 2—Geological map of the Port Phillip area. (From the ANZAAS Handbook, Melbourne, 1935).

Newer Basalt is displaced across the fault near Bannockburn, The Anakies and Bacchus Marsh, while late movements have modified drainage in the valleys of the Moorabool and Werribee rivers. From the foot of the Rowsley Fault, a gently sloping plain extends east to the shores of Port Phillip Bay, interrupted only by the volcanic cones of The Anakies and the residual granitic peaks of the You Yangs. The Palaeozoic granites rise through a surface cover of alluvium and Newer Basalt which on parts of the western shore passes beneath the waters of Port Phillip Bay (Fig. 2).

In addition to the two major structures, several subsidiary structures contribute to the present outline of the Bay.

Near Geelong in the south-west, the Lovelybanks Monocline runs north for 8 miles between Corio Bay and the Rowsley Fault, then trends north-west towards The Anakies. Its close association with the Rowsley Fault is indicated by a similar sense of movement (downthrow to the east) and evidence of Late Pleistocene to Recent activity. Newer Basalt is warped across the monocline, and near Geelong the course of the Moorabool River has been modified by Recent movements.

In the south-west, a system of east-west structures extends along the north side of the Barrabool Hills to the Geelong suburb of Newtown, with uplift on the south and downthrow to the north. This structural trend extends east to near Curlewis on the shores of the Bellarine Peninsula. West of Geelong, uplift along a line south of the present Barwon River has resulted in the elevation of Mesozoic sandstones, now undergoing dissection to form the Barrabool Hills (Coulson, 1960). As in the structures further north, movement post-dates present drainage. At Queen's Park, Geelong, the valley of the Barwon has been interrupted by faulting and the river has cut a gorge through the uplifted block with a corresponding development of upstream terraces.

East of Geelong, along the southern shores of Corio Bay, the Curlewis Monocline controls the northern edge of the Bellarine Peninsula horst, where Miocene limestones and clays are warped down to the north and pass beneath the floor of Corio Bay (Coulson, 1933). The age of movements, by association with other faults in the area, is late Quaternary. The combined effects of these, and movements of similar age on the Lovelybanks Monocline, have produced a triangular fault-angle depression or local basin within the sunkland. When flooded by rising sea level, this formed Corio Bay.

The south-eastern margin of the Bellarine Peninsula is controlled by the Bellarine Fault, which Keble showed extending into Bass Strait to near Cape Otway in the south and across the floor of Port Phillip to Beaumaris in the north (Keble, 1946; Fig. 1, 2; 1950, Fig. 43). Later evidence from bores on the Bellarine Peninsula indicates the fault has a more northerly trend than indicated by Keble, and does not extend across Port Phillip Bay (see Spencer Jones, 1962).

In the north, the Beaumaris Monocline forms a north-easterly trending structure with downthrow on the south-east and uplift on the north-west. It is expressed in cliffs near Beaumaris where Pliocene ferruginous sandstones are warped into a dome near Rickett's Point. This structure controls the coastal indentation from Rickett's Point to Mentone and

Mordialloc. On the upthrown side, resistant sandstones form the cliffed headlands at Rickett's Point, while on the downthrown side Quaternary and Recent deposition has occurred at Mordialloc, Carrum and Frankston.

To account for a great increase in the thickness of Older Basalt near Flinders, Keble (1950) postulated a fault trending north-west across the southern side of the Mornington Peninsula towards Mud Island with downthrow to the south. He called this the Flinders Fault, but confirmatory evidence for its existence is not available.

Other structures of lesser importance have been suggested or established around the coast of Port Phillip Bay including the Gellibrand Fault (Condon, 1951), the Footscray Warp (Keble and Macpherson, 1946), the Chechingurk and Balcombe Faults (Keble, 1950) and Manyung Rocks Fault (Gostin, 1964). Their direct influence on the topography of the area is insufficient to warrant consideration here.

The main geological structures are reflected in the gravity anomalies recorded in the Bay by Gunson, Williams and Dooley (1959). The principal feature of the gravity map is the large negative anomaly in the south with positive anomalies on the east and west over both Mornington and Bellarine Peninsula horsts (Fig. 3). In the south-east, the trends of the anomaly contours correspond closely to the observed and postulated positions of Selwyn's Fault. Between Dromana and Cape Schanck where the fault crosses the Peninsula, steep anomaly gradients closely follow the fault scarp and cross the coast near Dromana. They then swing north-east, corresponding to the postulated off-shore position of the fault, dying out in intensity towards Frankston, where displacement decreases towards the hinge of the fault (Hills, 1951). A gravity contrast of 45 milligals exists between the negative anomaly centred near Mud Island and the " high " located over the Mornington Peninsula. The gravity minimum thus corresponds to the area of predicted maximum downwarping in the sunkland.

The gravity pattern suggests the existence of a second structure sympathetic with the Rowsley Fault located near Sorrento (Fig. 3).

The subsurface stratigraphy in the region of the anomaly, is known only from evidence in the Sorrento Bore. However, the thickness of Recent sediment in the Bay is insignificant compared to Tertiary and Mesozoic sequences in the area. Without detailed stratigraphic or density information, the magnitude of the total displacement can only be estimated from the Sorrento Bore where displacement in excess of 1,700 feet is indicated (Chapman, 1928) although total displacement of 3,000 feet to 4,000 feet is probably more realistic.

Further north, Tertiary and Mesozoic sediments probably decrease in thickness on Palaeozoic basement rising towards the areas of positive gravity anomalies in the northern parts of Port Phillip Bay and the coastal area near Beaumaris.

Small negative anomalies correspond to the structural depressions in the Carrum Swamp and Moolap Sunkland, but the established east-west structures from Geelong to Portarlington are not evident in the gravity picture. Moreover, the postulated Flinders Fault (Keble, 1950) is not reflected in the gravity evidence.

FIG. 3

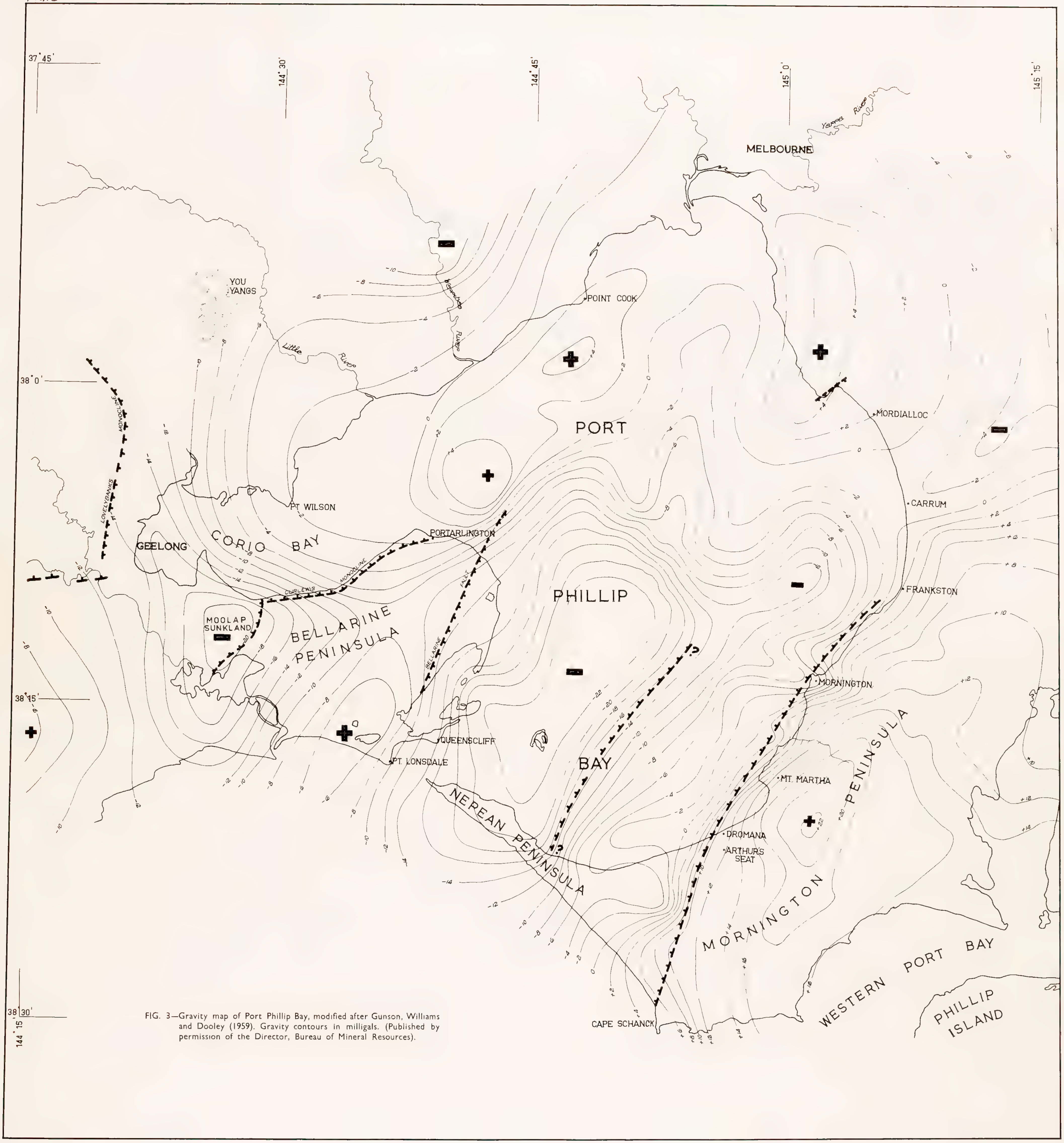
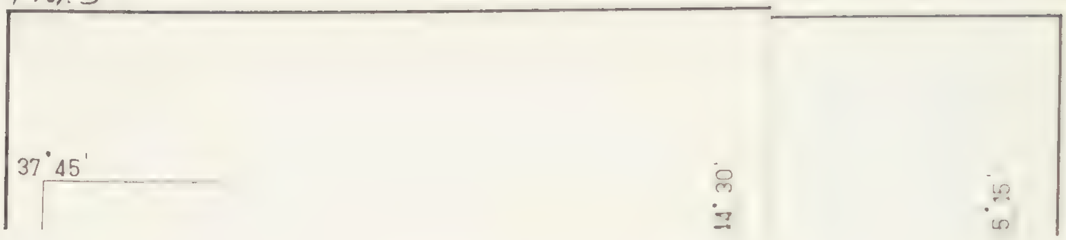


FIG. 3—Gravity map of Port Phillip Bay, modified after Gunson, Williams and Dooley (1959). Gravity contours in milligals. (Published by permission of the Director, Bureau of Mineral Resources).

FIG. 3



COASTAL GEOLOGY.

Rock types outcropping around the coast of Port Phillip Bay vary from east to west.

On the east coast, Palaeozoic granitic rocks outcrop on the Mornington Peninsula at Mt. Eliza, Mt. Martha and Arthur's Seat. Between Balcombe Bay and Frankston, the coastal sections are composed mainly of Tertiary Older Basalt, Tertiary calcareous clays and Upper Tertiary sandstones and one small occurrence of Mesozoic sandstone. Upper Tertiary sandstones also outcrop on the cliffed sections and foreshores further north from Beaumaris to Brighton.

Between Beaumaris and Frankston, in the low-lying area formerly occupied by the Carrum Swamp, Quaternary alluvium has accumulated. This is an area of local subsidence within the sunkland, formed by the combined effects of downthrow on the Beaumaris Monocline and Selwyn's Fault.

The western coastline of Port Phillip Bay lies close to the edge of the extensive Newer Basalt flows, which extend west to the South Australian border. The lithologies on the west coast from Williamstown to Geelong consist exclusively of Quaternary alluvium and Newer Basalt. Basalt is continuous from Williamstown to 3 miles north of the Werribee River, where low cliffs are cut in Quaternary alluvium. These extend 2 miles south of the river mouth to the basaltic plain which continues along the coast to Hovell's Creek, Corio Bay.

The eastern shores of Corio Bay are cut in horizontal Tertiary sands, limestone and calcareous clay. Deposits of Quaternary sandy clays form Point Henry Peninsula on the southern shores of Corio Bay, while Quaternary non-marine limestone occurs in the valley of Hovell's Creek at Limeburner's Point.

The northern shores of the Bellarine Peninsula near Curlewis and Portalington consist of Tertiary Older Basalt, limestone and calcareous clay. Upper Tertiary ferruginous sandstone forms cliffs east of Portarlington and near St. Leonards.

Aeolian deposits are widely distributed around the margins of Port Phillip Bay. These consist of two different types: siliceous dunes developed near Brighton, Frankston and on the Bellarine Peninsula near Drysdale, and calcareous dunes developed along the southern coastline between Cape Schanck and Barwon Heads. The siliceous dunes lie inland from the present coast and are now largely stabilized by vegetation. Large irregular dunes with deep podsolic soils occur near Frankston and extend west to near Cranbourne. Near Brighton and Mordialloc, the dunes have more regular longitudional form with low elongate crests and swales. Whincup (1944) suggested they were formed by north-westerly winds during a period of Quaternary aridity.

An additional siliceous dune occurs 1½ miles in from the present coastline in the Carrum Swamp. It extends for approximately 8 miles from Frankston as a low ridge on which Wells' Road is built. From the existence of marine shell beds along the seaward edge of the dune, Hills (1940) concluded it was a coastal foredune stranded inland by coastal emergence.

The calcareous aeolianite is confined to the present coastline but continues to 428 feet below sea level in the Sorrento bore (Chapman, 1928). It extends from Cape Schanck along the Nepean Peninsula to Port Phillip Heads and Queenscliff. Its northerly extent is not defined, but shallow bores reported by Keble (1946, 1947) on the shoal near Mud Island penetrated a thin veneer of unconsolidated Recent sands to 30 feet, overlying dune limestone.

In the calcareous dunes, successive periods of dune formation alternated with periods of soil formation. Up to five buried soils have been recorded in dunes on parts of the Victorian coast (Hills, 1939; Boutakoff, 1963).

On the northern margin of Port Phillip Bay, in the region of the Yarra estuary, fluviatile sediments near Yarraville interfinger with marine and estuarine deposits (Dorman & Gill, 1958; Gill, 1961).

A large triangular-shaped deposit of alluvium occurs on the western coast and extends from the mouth of the Werribee River inland to the township of Werribee. River cliffs up to 25 feet high are cut in clays and sandy clays in this area which has been referred to as the Werribee Delta (Condon, 1951). Along the coast, deep fluviatile sediments extend 3–4 miles north and south of the river mouth. They were not deposited by the present Werribee River which cuts through them, and are not deltaic in any sense except that they occur near the present river estuary. They originated by deposition in an earlier (?Pleistocene) phase of stream activity in the area.

COASTAL GEOMORPHOLOGY.

Topographic relief varies considerably around the coast of Port Phillip Bay.

In the south-east, Palaeozoic granitic rocks at Mt. Eliza, Mt. Martha and Arthur's Seat rise to 500, 520, and 1,000 feet respectively. Further north, the coastal elevation rises from the lowlands of the Carrum Swamp, which is often only a few feet above sea level, to an undulating surface beween Beaumaris and Brighton, which averages 50 to 100 feet above sea level.

The western coast along the basaltic plain is one of uniformly low relief. Coastal elevations from Williamstown to Geelong never exceed 50 feet, and are rarely more than 20 feet above sea level. Relief increases in Corio Bay and along the Bellarine Peninsula, reaching a maximum near Curlewis, where Mt. Bellarine, 2 miles inland, reaches an elevation of 463 feet. From Portarlington, relief decreases towards St. Leonards until, from St. Leonards to Queenscliff and Point Lonsdale, the landward elevation of the coast is often only a few feet above sea level, as on the shores of Swan Bay.

Cliffs.

Relatively high cliffs alternate with sandy beaches along much of the eastern coast of Port Phillip Bay.

Cliffs in Pleistocene aeolianite occur in the occasional headlands on the north side of the Nepean Peninsula, between Point Nepean and Dromana. More extensive cliffs occur on the upthrown side of Selwyn's

Fault between Dromana and Frankston. Cliffs are cut in granitic rocks at Dromana, Mt. Martha and Oliver's Hill, near Frankston. Between Balcombe Creek and Frankston, cliffs are cut in Miocene clays and Pliocene ferruginous sandstone (Baxter Sandstone of Keble, 1950). This often forms resistant headlands as at Fisherman's Beach and Schnapper Point, Mornington (Chart I back of volume).

Further north, cliffs occur in Upper Tertiary ferruginous sandstone and unconsolidated sands (Sandringham Sands of Gill, 1957) in the rising topography near Beaumaris and continue north towards Sandringham, dying out as relief decreases near Brighton.

Along the eastern coast, the most active cliffs are developed on headlands, and often alternate with vegetated cliffs backing sandy beaches in protected bays, as in Canadian Bay, Frankston, and Half Moon Bay, Black Rock.

Comparatively few cliffs occur on the western coast, particularly between Williamstown and Geelong. The only cliffs developed in this area are cut in the alluvial deposits north and south of the Werribee River. North of the river mouth, low cliffs averaging approximately 15 feet high, extend 3 miles towards Point Cook. Further south in Corio Bay, steep active cliffs up to 50 feet high extend from North Shore to Eastern Beach, and recur on the tip of Point Henry Peninsula. The Eastern Beach cliffs are cut in marine Tertiary limestone, marls and sands (Bowler, 1962) but those on Point Henry Peninsula are developed in Pleistocene clays and sandy clays.

East along the Bellarine Peninsula, low cliffs are developed in tilted Tertiary clays and limestone (Coulson, 1933) and reach a maximum elevation of 30 feet near Portarlington. South-east of Portarlington, cliffed headlands occur at St. Leonards (30 feet in Pliocene ferruginous sandstone) and at Queenscliff, (approximately 50 feet in Pleistocene aeolianite).

On the higher energy ocean beaches facing Bass Strait, the coastline from Point Lonsdale to Cape Schanck is dominated by erosion. High cliffs are developed in aeolianite along this coast, reaching a maximum height of 180 feet near the ocean beach at Sorrento. Near Cape Schanck on the upthrown side of Selwyn's Fault, cliffs up to 300 feet high occur in Older Basalt.

Shore platforms.

Additional evidence of coastal erosion is provided by broad shore platforms developed on rocks of intermediate hardness around the coast in the Port Phillip region. They occur extensively on the cliffed ocean beach from Point Lonsdale to Cape Schanck. At Point Lonsdale, platforms extend seawards from the cliffs for almost a quarter of a mile, and are broken in places by deep channels. Hills (1949, p. 145), commenting on these, noted " they are remarkable for their almost perfectly plain surfaces, marred only by rare residuals, potholes and chasms, and equally for their horizontality, great breadth, and lateral extent."

Platforms developed within Port Phillip Bay are usually narrower and more limited laterally than those on similar rocks on exposed parts of the Victorian coast. At Point Lonsdale and Point Nepean, broad aeolianite platforms backed by high, actively eroding cliffs continue for only a short

distance inside Port Phillip Heads, although the rock type remains unchanged. Inside the Bay, abraded dune limestone is covered by sandy beach deposits at Queenscliff and Portsea.

Jutson (1940) and Hills (1940) have described platforms developed in granodiorite at Mt. Martha. Here the widest platforms occur in zones of softer weathered rock on the northern and southern margins of the intrusion. The limited development in the centre reflects the resistant nature of the fresh rock to wave action.

Further north, platforms occur in ferruginous sandstone near Mornington, Frankston, Beaumaris and Sandringham, and a minor development is recorded on Newer Basalt near Williamstown (Hills, 1940). The best developed platform in the northern part of Port Phillip Bay occurs in horizontally bedded Pliocene ferruginous sandstone near Rickett's Point, Beaumaris. Here the near-horizontal platform extends seawards 300 feet from the cliffs which rise to 60 feet and form the headland at Table Rock. Eroded platform remnants form shallow bedrock outcrops near Brighton and St. Kilda.

A feature of the platforms in Port Phillip Bay is their almost exclusive occurrence on the east coast. The only occurrence on the west, besides that at Williamstown, is at Portarlington, where a small platform is cut in Older Basalt (Jutson, 1931).

The problem of platform development within Port Phillip Bay is complicated by the presence on the east coast of platforms above the level of present high tides.

Beaches.

Broad sandy beaches occur in two main regions on the eastern coastline of Port Phillip Bay. One extends 11 miles from Mordialloc to Frankston, the other 16 miles from Dromana Bay to Portsea on the northern side of the Nepean Peninsula (Chart I back of volume). These constitute the most extensive areas of clean, well-sorted beach sands in Port Phillip Bay. In the Mordialloc–Frankston region, the beach grades seawards into a broad zone of off-shore sands (see Beasley, this volume), and is supplemented on the landward side by a sandy foredune, running the length of the coast from Chelsea to Frankston (Hills, 1940; Whincup, 1944).

Smaller beaches in bay heads and pocket beaches alternate with eroding headlands on the Mornington Peninsula from Dromana Bay to Frankston, and further north from Beaumaris to near Brighton. These are usually narrow and relatively thin, and often rest on an abraded rock surface as at Balcombe Beach, Beaumaris, Sandringham and Brighton.

The eastern beaches are the popular holiday resorts in Port Phillip Bay, and have largely influenced the concentration of residential and tourist development on the east coast.

On the west coast, narrow sandy beaches extend continuously from Williamstown to Corio Bay. Often a thin veneer of sand overlies basalt and grades out to a shallow off-shore zone as near Altona, Point Cook, and south of Little River. The sands are usually poorly sorted and often carry large quantities of accumulated drift material, including decomposing seaweed.

Narrow beaches continue along the low cliffed area of the Bellarine Peninsula from Geelong to near Curlewis and Portarlington. Beyond Portarlington, the sand cover becomes broader and deeper due to increased exposure of the area to currents and waves. Near Queenscliff and Point Lonsdale, exposure to tidal currents and ocean swell through Port Phillip Heads has developed a broad well-sorted sandy beach overlying abraded dune limestone.

Grain sizes and mineral composition of beaches varies around the coast. In a detailed study of the beach sands of the Brighton area, Baker (1963) recorded significant variations in sorting, median parameters and mineral constituents over short distances along the coast. Beach sands here consist principally of detrital quartz with the content of calcareous shell fragments varying between 7 per cent. and 35 per cent. (Baker, *op. cit.*, Table 10).

Off-shore bars.

Shallow off-shore sand bars occur opposite beaches on both the east and west coasts of Port Phillip Bay.

On the east coast, they extend from Mordialloc to Frankston, and from Dromana to Sorrento. In the Mordialloc–Frankston region, several bars often remain parallel to the beach for up to seven miles. The number of bars may vary in places, although two are usually present from Mordialloc Creek to Seaford. At Frankston in August, 1960, two bars were present north of the jetty, but by August, 1964, three bars had formed in this area. These persisted at least until February, 1965. Over much of their length, the regularity of bars is affected by annual and seasonal variations in winds and waves. Near Seaford, however, the bars are nearly always irregular, and small lobate bars separated by rip channels often develop obliquely to the beach.

On the Nepean Peninsula, irregular bars commence in Dromana Bay, and become very complex further south near Rosebud where a system of multiple bars extends in a continuous zone to near Sorrento. In this zone near Rye and Blairgowrie, seven to eight bars are parallel to each other and sub-parallel to the beach. They occur in water 7 feet to fifteen feet deep on a sandy shoal extending 2,500 feet off-shore until the outer edge drops steeply to 40 feet in Capel Sound. On the seaward edge of the shoal the bars are regular, but become more irregular towards the shore, where in places lobate and oblique bars emerge to form small sand barriers. These join the beach and result in complex cuspate structures.

A single bar runs the length of Balcombe Beach, maintaining a position approximately 700 feet off-shore, and joins the southern headland, Balcombe Point.

In the shallow waters along the west coast, a system of small irregular bars extends from Altona, south towards Point Cook and to beyond Little River. At low tide, low ridges and runnels belonging to this system are exposed e.g. near Altona. At low water, waves often break on the outer limit of the bar shoal which varies in depth from 5 feet to 10 feet below low water. In the north, the shoal extends 1,600 feet off-shore, comes in to near 500 feet off Point Cook and remains parallel to the coast down to the Werribee River. Off the mouth of the river,

two parallel bars are displaced seawards. These approach the coast again south of the river, and the bar system follows the coast to Little River and Kirk's Point, where the shoal again extends further out to sea towards Point Wilson.

Bar development on sandy shoals is more persistent along the entire length of the west coast than on the east, where single and multiple bars are developed only off sandy beaches. But in the east coast systems, individual bars are larger and more regular than on the west, suggesting differences in the controlling wave energy from east to west.

Bars form only in the shallow off-shore zone where bottom sands are constantly moving in response to changing winds and wave conditions.

Near-shore topographic profiles have been constructed from detailed charts prepared by Cox (1861, 1862) with soundings taken at approximately every 120 yards. Although these do not show individual bars, they reveal a consistent topographic break on the edge of the sandy shoal on which the bars occur. On the east coast, this break occurs at approximately 24 feet in both the Mordialloc–Frankston and Dromana–Rosebud areas (Fig. 4). On the west coast, the break occurs at approximately 14 feet, with some variations along the coast depending on local bedrock outcrops. The entire shoal is a depositional feature in the shallow zone of relatively high wave energy. The depths to the topographic break on the outer edge reflect variations in wave energy distribution from the beach to the off-shore zone on different parts of the coast.

Sand Ridges.

Around the coast of Port Phillip Bay, a variety of sand ridges occurs, many of which lack the characteristic features of true beach ridges as described by Johnson (1919) and Davies (1958).

Widely separated low sand ridges with lobate landward extensions are associated with shell beds containing Recent faunas from near Altona to Point Cook. These lack the closely spaced, fine-textured "crest-and-swale" topography of true beach ridges as noted by Hills (1940), although sometimes regarded as such (Gill, 1961).

Near Point Cook, a narrow sand belt with a low ridged topography follows the coast south towards the cliffed section north of the Werribee River. The ridges are closely spaced, but weakly defined unlike typical beach ridges.

At Point Richards near Portarlington, a ridged foreland has developed over shell beds, but again lacks the fine-textured beach ridge topography. Sand ridges are still developing on the present coast of the foreland, some of which have not yet been fixed by vegetation.

At Observatory Point near Point Nepean, vegetated parallel sand ridges extend 1,000 feet inland from the present coastline. Here a linear "crest-and-swale" topography has developed resembling the beach ridges described by Davies (*op. cit.*). Ridges have developed under the influence of refracted swell entering the Bay through Port Phillip Heads. They are thickly vegetated and are not developing under present conditions.

Fig. 4.—Near-shore topographic profiles constructed from detailed soundings of Cox (1861, 1862). Profiles a–c are from the west coast, d–g from the east coast. Shoals developed close to the shore constitute zones of mobile sand, often carrying off-shore bars. These zones are subject to rapid profile changes in response to local sand and wave conditions. The outer edge of the sand shoal drops into deeper water off the east coast than the west, reflecting the high-energy wave conditions generated on the east coast by exposure to northerly and westerly winds.

At Swan Point, on the eastern tip of Swan Island, a cuspate foreland of sand ridges has developed during historic time. Here little vegetation cover has been established; the ridges are stabilized only by a sparse grass cover. A comparison between recent photographs of the area and the oultines of the island surveyed by Cox (1864) shows a progradation of approximately 800 feet along half mile of coastline during the last 100 years.

On the eastern side of the Bay between Mordialloc and Frankston, a sand ridge or coastal foredune extends along the present coastline of the Carrum Swamp (Hills, 1940). Near Aspendale, two parallel ridges occur south to Frankston with Kananook Creek developed in the swale between. These are aeolian foredunes, resting on beach deposits as shown by Whincup (1944).

The coastal sand ridges, with the exception of those at Swan Point and the tip of Point Richards, have developed under conditions which no longer exist in Port Phillip Bay. Many are stranded inland above the level of present high water, and have developed while sea level was relatively higher than at present.

In summary, the coastal features on the east are geologically and physiographically distinct from those on the west (cf. Jutson, 1931, and Hills, 1940). Not only do geological structures and lithological types vary from east to west, but also the extent of erosional and depositional features developed. Cliffs and shore platforms, common on the east, are rarely and only weakly developed on the west. Broad well-sorted sandy beaches, sometimes with a coastal foredune, are more representative of the east coast than the west.

The most extensive sand ridge development occurs on the west coast. This has sometimes been regarded as exhibiting the greatest degree of progradation (Jutson, 1931), but the west coast has maintained an irregular outline even though it has low relief, and only a small quantity of sediment is necessary to produce coastal straightening. The smooth arcuate beaches on the eastern coast formed by extensive infilling of formerly large coastal indentations, have no equivalents on the west. The alternation between erosion on headlands, and deposition in bays, characteristic of the east coast does not occur on the west. Moreover, the observed progradation by sand ridge construction is not due to accretion at present sea level but is complicated by possible tectonic and eustatic factors in the coastline evolution.

SUBMARINE GEOLOGY.

Topography.

The bathymetric contours and cross-section (Fig. 5) show Port Phillip Bay is deeper on the east than on the west. The near-shore region on the east, especially near Frankston and Mt. Martha, maintains a steeper gradient than corresponding areas on the west. This asymmetry is due to the major influence of Selwyn's Fault with the fault-angle depression developed close to the Mornington Peninsula.

During 1964, continuous fathograms were obtained on selected traverses across the Bay. The location of traverses is shown on Chart I. (back of volume) with corresponding topographic sections at reduced scale in Fig. 6.

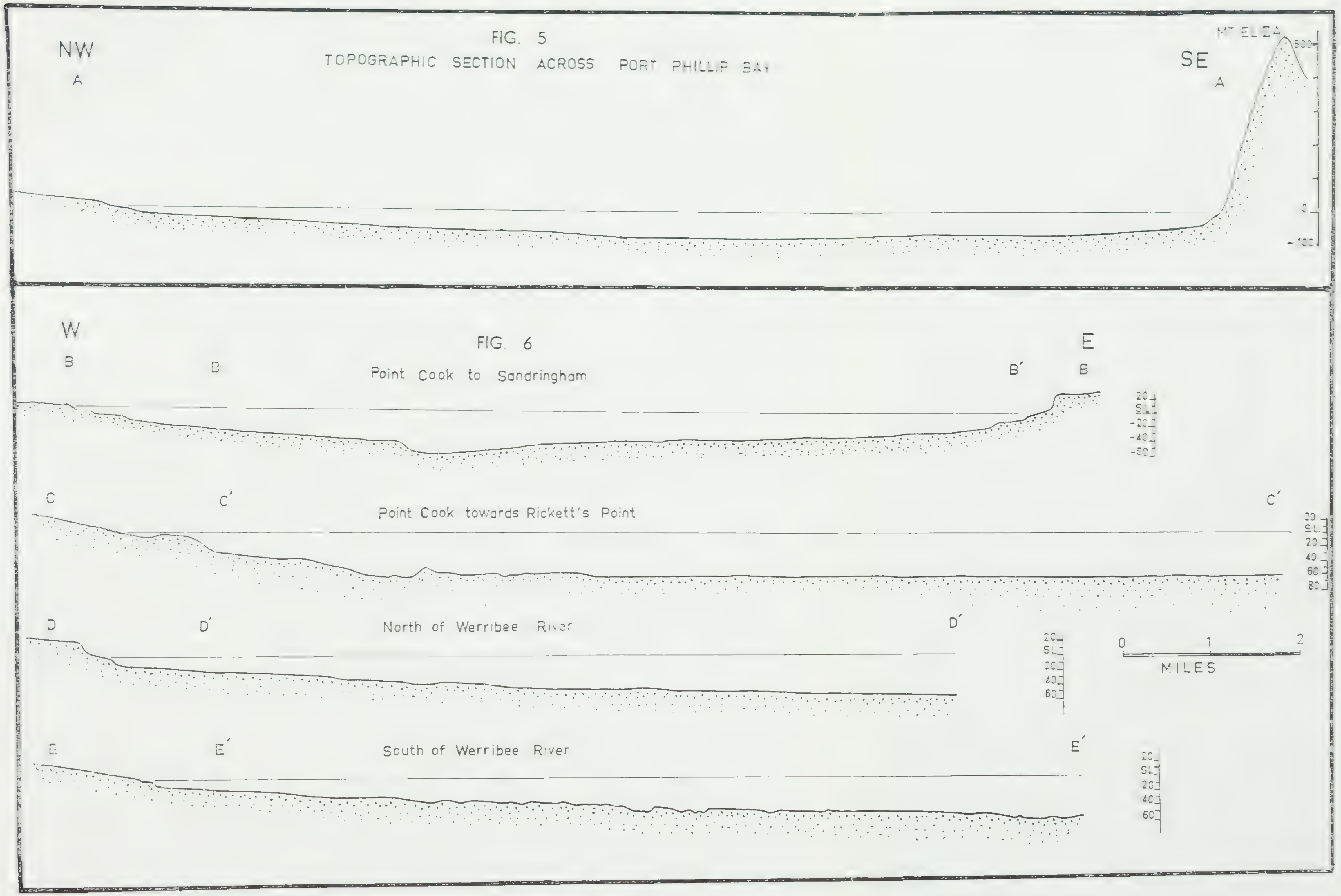


Fig. 5.—Topographic section through Port Phillip Bay constructed from Admiralty Chart 1171 surveyed by Cox (1864).

Fig. 6.—Detailed profiles showing irregularities in the bottom topography of Port Phillip Bay ; constructed from fathograms obtained through the assistance of the Department of Public Works, Ports and Harbours Branch. (For the location of profiles see Chart I back of volume.)

Allowing for vertical exaggeration, the sea floor from east to west across the Bay is very flat with small irregularities confined to the western side. The steepest slopes on the irregularities shown on traverses B–B and C–C, when reduced to natural scale, have gradients of 1 in 37 and 1 in 66 respectively. Both are in the area regarded by Keble (1946) as the location of a drowned river channel formerly continuous with the Yarra River. Initial irregularities on the land surface which was submerged by marine transgression in the formation of Port Phillip Bay, have either been eroded down by wave action or smoothed out by the uneven deposition of Recent sediment.

Recent sediments.

In cores obtained by the author from the floor of Port Phillip Bay, two separate formations are represented:

(*a*) Recent marine sediments which disconformably overlie;

(*b*) an older formation, represented usually by the bottom few inches in some cores.

The main features distinguishing the two formations are summarized in Table 1.

TABLE 1.

Recent Marine Sediments.	*Older Formation.*
Unconsolidated sands, silts and clays ..	Consolidated clays, and sandy clays.
Carbonate common in foraminiferal and and molluscan shells.	Carbonate rare, occasionally in nodules indicating secondary mobilization and cementation.
Unoxidized, mottling rare	Evidence of oxidation common, mottling common.
Non-micaceous	Sometimes micaceous.
Clays unorganized	Clays often organized into ped and cutan structures typical of soil organization (Brewer, 1960).
Plant remains absent	Plant remains sometimes present as root fibres.
Recent foraminifera	Replaced Tertiary foraminiferal moulds.

Summary of the characteristic features of the two formations represented in cores through Recent sediments in Port Phillip Bay.

All the characteristic features of the older formation are not necessarily present in any one core, e.g., in-shore near Sandringham Harbour the older formation is represented by oxidized Tertiary sands with limonitically replaced foraminiferal moulds, but $2\frac{1}{2}$ miles south of Sandringham, 4 feet of Recent sediments rest on stiff consolidated silty clays showing soil organization (peds and cutans). Underwater coring in the older formation is difficult due to the stiff consolidated nature of the material. Maximum penetration into this material of only 1 foot has been effected, and extraction of the corer at this depth proved difficult even with a powerful winch.

Of the 50 cores from the northern part of the Bay, the older formation is represented in seventeen. Cores from near-shore stations often penetrate only 1 foot or 2 feet before encountering the older material. Of those from depths greater than 30 feet, ten have reached the older surface after penetrating an average of 3–4 feet of Recent marine sediments, and sixteen failed to reach the base of Recent sediments after penetrating 6 feet to 8 feet. Further south, a core in water 60 feet deep near the West Pile Light, 2½ miles east of St. Leonards, penetrated 10 feet into Recent marine sands without reaching the base of that formation.

The thickness of Recent sediment is therefore variable throughout the Bay. In the north, which is an area of relatively high deposition close to the Yarra estuary, Recent marine sediment forms only a thin cover on the older consolidated material. But in the south near the Nepean shoal, a deeper sand cover has accumulated under the influence of strong tidal currents through Port Phillip Heads.

Samples from two cores in the Recent sediments were submitted to Mr. A. C. Collins who kindly examined the foraminiferal content. The cores studied were No. 19 from a depth of 50 feet and No. 25 from 57 feet, located 2½ miles W.S.W. and 4 miles S.W. from Sandringham Harbour respectively. The cores consist of 153 cms. (No. 19) and 115 cms. (No. 25) of marine silty clays. The foraminiferal assemblages reported by Mr. Collins showed significant differences in ecology from top to bottom of the cores. The bottom samples yielded assemblages typical of enclosed Victorian waters (39 species were recovered from No. 19, 22 from No. 25). The top samples furnished fewer species (17 from No. 19, 13 from No. 25), both of which were dominated by *Ammonia cf. beccarii* (Linne). This genus has a wide tolerance of salinity variation but favours low salinity, and is often found in estaurine or lagoonal environments (Collins, pers. comm.). Its occurrence indicates a salinity decrease in Port Phillip during the period of deposition represented by the sediment in the cores.

A full description of cores is being provided by Link (1965).

Bedrock outcrops.

In shallow areas, bedrock sometimes outcrops through a thin cover of Recent sediment to form rocky shoals or " reefs ".

On the west coast, basalt outcrops on the sea floor near Williamstown, Altona and Point Cook, and forms a submarine ridge south from Point Lillias and Point Wilson in Corio Bay. A basalt sample from the Point Wilson ridge obtained during dredging is a medium to fine grained vesicular iddingsite labradorite basalt. It is identical with flows on the plains near Geelong, and it therefore was extruded under sub-aerial conditions before the formation of Port Phillip Bay.

On the east coast, resistant submarine outcrops of Pliocene ferruginous sandstone occur at the Anonema Shoal south of Sandringham, near Beaumaris and off Fisherman's Beach, Mornington. Extensive areas of rock also occur off headlands on the Mornington Peninsula between Frankston and Balcombe Bay as well as in the north from Beaumaris to Black Rock and Brighton.

Tidal scour often exposes bedrock in channels near Port Phillip Heads and on the Nepean shoal. Channels are cut in Pliocene ferruginous sandstone off St. Leonards and in Pleistocene aeolianite near Port Phillip Heads. Eroded benches and cavernous undercut ledges in dune limestone have been examined by the author to approximately 80 feet below sea level near the entrance to Port Phillip Bay and are known to continue to much greater depths. In the narrowest constriction between Point Lonsdale and Point Nepean (Fig. 7), a deep tidal colk with near vertical sides has been scored to nearly 300 feet (Armiralty Chart 2747; Benson and Raeside, 1963).

EVOLUTION OF PORT PHILLIP BAY.

Terracing and Eustatic Sea Level Changes.

Evidence from coasts throughout the world has clearly established the significance of the post-glacial rise in sea level which commenced approximately 18,000 years ago when sea level was some 300 feet lower than at present (Shepard, 1961; Fairbridge, 1961). The rise to near its present position has flooded river valleys, estuaries and lowlands in many parts of the world. In Victoria, both Port Phillip Bay and Westerport Bay (Fig. 1) owe their present outlines to the combined effects of tectonic movements which formed the sunklands, and the post-glacial eustatic rise which later flooded them.

Keble (1946, Fig. 2) has used the bathymetric contours of Port Phillip Bay to reconstruct the course of the Yarra trunk stream and its tributaries which drained the former land surface now occupied by Port Phillip Bay. He showed the Yarra discharging through the centre of the area now occupied by the Bay, picking up tributaries from east and west, and passing south to the ocean across Nepean Peninsula. On the ocean side of the Peninsula, submerged outlets or tideways and river channels were postulated from indentations in the bathymetric contours. However, detailed fathograms obtained by the author inside the Bay across the projected underwater trend of the Werribee and Little rivers, has provided little evidence for the existence of channels in the present submarine topography. In the north, submarine irregularities on the profile B–B, may represent the valley of the Yarra River, but on the next profile south (C–C) and remaining profiles, stream courses cannot be recognized. Additional fathograms from the ocean side of the Nepean Peninsula have revealed no evidence of the tideways and river channels claimed by Keble. Jennings (1959) has further questioned the reliability of the seaward extension of the Yarra channel into Bass Strait (Keble, 1946, Fig. 12). Similarly, evidence for eustatic terraces inside the Bay as claimed by Keble (*op. cit.*) do not show on continuous soundings in Fig. 6. Traverse E–E south of Little River is close to the line of section illustrated by Keble (1950, Fig. 43) but does not show terraces at the depths claimed. They were probably due to inaccuracies in contouring and the choice of the section line position rather than to real breaks in slope at consistent depths.

On the ocean side of the Nepean Peninsula in King Bay Sound, bathymetric contours show an undulating topography sloping away from the coast to the relatively flat sea floor of Bass Strait at approximately

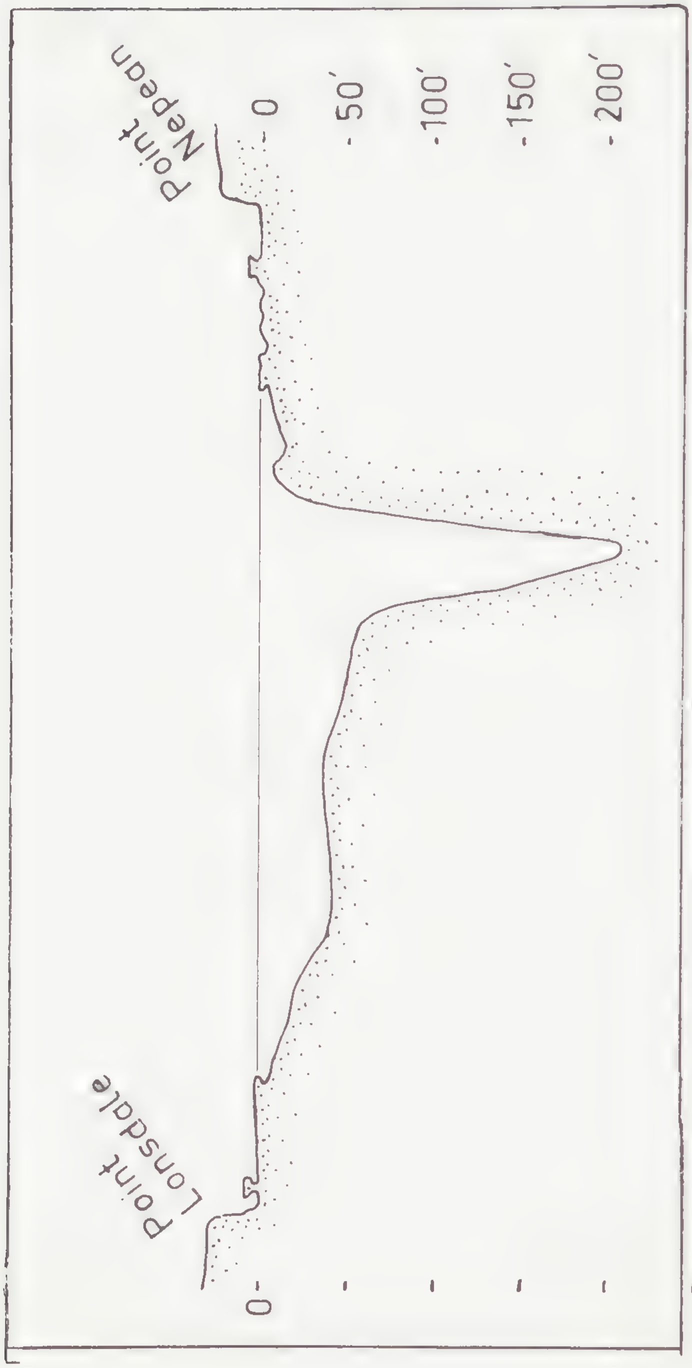


Fig. 7. East-west topographic section across Port Phillip entrance, showing the deep scour channel cut in aeolianite at the point of tidal construction.

40 fathoms deep. From a reconstructed contoured chart of this area, Keble (1946, Fig. 8) illustrated eustatic erosion benches at 42 feet, 84 feet, and 210 feet, and later at 120 feet and 210 feet (Keble, 1950, Fig. 42). These like the eustatic levels inside the Bay, were not reproduced by continuous soundings in the area.

Eustatic sea level changes have been further invoked to explain river terraces in the valleys of the Werribee and Maribyrnong Rivers and Moonee Ponds Creek. In the Maribyrnong River, Keble and Macpherson (1946) recognized three terraces which they named Keilor, Braybrook and Maribyrnong. Gill (1955, 1961) modified this sequence to include an older and higher terrace and excluded the Braybrook. The sequence as presently known at Keilor, from highest (oldest) to lowest (youngest) is Arundel, Keilor and Maribyrnong. The Arundel terrace, which continues into the Yarra Delta, is correlated with a warmer period before the last glaciation corresponding to the Riss–Würm interglacial in the European sequence (Gill, 1961). A sequence of carbon samples obtained through the Keilor terrace sediments have yielded the following radiocarbon dates:

> 8,500 (± 250), 15,000 (± 1,500) and 18,000 (± 500) (for earlier references see Dury, 1964).

The terrace sediment was therefore deposited at the end of the last glaciation and during the post-glacial transgression. The Maribyrnong terrace represents the river flood-plain adjusted to present sea level.

Pleistocene Tectonism and the Formation of Aeolianite.

In an area of tectonic instability such as the Port Phillip Sunkland, it is difficult, and sometimes impossible, to evaluate the relative importance of tectonic deformation and eustacy especially when both processes may have operated simultaneously.

Definite evidence of late Quaternary faulting exists on the west where late flows of Newer Basalt are tilted near Geelong, and drainage is affected in the valleys of the Barwon, Moorabool and Werribee rivers. Further evidence of the extent of Pleistocene downwarping in the sunkland is provided by the occurrence of Pleistocene dune limestone to 428 feet below sea level in the Sorrento Bore (Chapman, 1928).

The significance of calcareous aeolianite in the evolution of Port Phillip Bay depends on the environment in which it formed. Formation during periods of low sea level has previously been suggested, based largely on evidence of aeolianite in Bermuda with similar buried soils, sedimentary structures and mineral composition. This was regarded by Sayles (1931) as having formed during periods of glacial low sea level. Formation near present sea level was later postulated by Bretz (1960) and confirmed by MacKenzie (1964).

In the Victorian aeolianite, the following features also suggest formation near present sea level:

1. In plan, the dunes are coincident with the present coastline intermittently from Portland in the west to Wilson's Promontory in the east. Seaward occurrences are limited to within a few miles of the present coast. Formation during glacial periods would require accretion of a transverse dune ridge inland from

the sand source along the glacial shoreline, which was then situated many miles southwest of its present position. This is inconsistent with the development of modern transverse dunes, which are always located close to the sand source.

2. The occurrence of up to five buried soils in dunes along much of the coastline indicates five alternate periods of stability and accretion. The superposition of alternatively younger dunes over older, separated by a soil horizon, requires an abundant source of calcareous sands close to the dune ridge during successive stages of dune accretion, a coincidence explained only by the occurrence of an active beach on the seaward side of the dunes.

3. The dunes show no evidence of submergence by interglacial high sea levels as might be expected if they had formed during periods of low sea level.

4. The depth to which aeolianite occurs in the Sorrento Bore (428 feet) is below the average depth of Bass Strait (approximately 300 feet), and below the deepest level accepted for glacial reductions in sea level. Some tectonic downwarping is therefore necessary even if the glacial theory were accepted.

The Victorian aeolianite, as in Bermuda, is therefore best explained by deflation of calcareous beach sands while sea level was close to its present position. Accumulation occurred during interglacials with intervening periods of stability and soil formation during phases of lower sea level. A similar account has been independently proposed by Boutakoff (1963) from a study of dunes in the Portland area. Jennings (1961) has also suggested formation of calcareous dunes on King Island, in Bass Strait, under climatic conditions similar to those of the present day.

The deep occurrence of aeolianite in the Sorrento Bore is due almost entirely to Pleistocene downwarping, which therefore exceeded 400 feet in the sunkland. In the same bore, an horizon at 498 feet containing Recent mollusca "exactly resembles estuarine beds" found at the mouths of present Victorian rivers (Chapman, *op. cit.*, p. 180). This provides further support for a large negative movement in the Port Phillip area during the Pleistocene.

Coastal Emergence.

The evidence of Recent coastal emergence in Port Phillip Bay has been disputed by many workers since the early studies of Selwyn (1854) and Lucas (1887).

Jutson (1931) reviewed the problem, but like Pritchard (1910), he was unable to cite conclusive evidence of emergence. Hills (1940), in a comprehensive examination of the evidence stated (p. 84), "definite evidence of Recent emergence has been observed at practically all localities where the conditions of erosion and deposition are such as to favour its preservation".

At many places on both the east and the west coast, beach deposits and shell beds occur inland and often rise above the level of present high water. On the south-east, Hills (*op. cit.*) described high level beach deposits extending from near Sorrento to Dromana, which rise 5 feet

to 6 feet above present high water. The bedding of shells, occurrence of paired valves, and the preservation of ornament and fragile shells indicate deposition below the swash zone, or even lower (Hills, p. 90, 1940). The extension of similar beds with Recent marine mollusca south into the Tootgarook Swamp was later established by Keble (1950).

In the Carrum Swamp, north of Frankston, marine shell beds extend inland to the stranded foredune near Wells' Road (Hills, *op. cit.*). The original level of the shell beds above present sea level is not known since compaction of the swamp occurred after draining. The absence of beach ridge development between Wells' Road and the present coastal foredune indicates a shift in coastline by means other than normal progradation, as indicated by Hills.

In the northern part of the Bay at Port Melbourne, formerly known as " Sandridge ", a system of coastal ridges existed on the seaward side of the West Melbourne Swamp. These were recorded by Selwyn (1854) and by Lucas (1887) as rising 7½ feet to 10 feet above highwater level. They rested on sands and Recent shells 2 feet above high water (Jutson, 1931), but have now been destroyed by industrial development and little detailed information is preserved (see also Pritchard, 1910, p. 41).

In the south-west, evidence of a former strandline occurs from south of St. Leonards to near Ocean Grove. In this area, widespread shell beds are located slightly above high water. Jutson (1931) noted,

> " the low-lying area in which Recent marine shells occur, between the high Tertiary belt and the Point Lonsdale–Ocean Grove ridge, comprises—
>
> (*a*) several low isolated ridges more or less elongated (which were islands in the ancient sea) and a less elongate ' peninsula ', all of dune limestone, and
>
> (*b*) four lakes of varying size ".

The lakes represent remnants of a shallow sea which once occupied this area and has now retreated to Swan Bay. They are isolated from the sea and from each other by a complex development of barriers and beach ridges (Gill, 1948). Thick shell beds occur on the floor of the Lake in well-stratified deposits with gently inclined bedding planes (Hills, 1940).

On the northern side of the Bellarine Peninsula near Portarlington, a system of weakly developed ridges and associated shell beds forms a cuspate foreland at Point Richards. The coastline has prograded approximately 3,000 feet from the landward margin of the ridges which mark the former position of the shoreline. Further west, on the south-western shore of Corio Bay, Jutson (*op. cit.*) recorded an oyster bed of Recent origin up to 8 feet above high water.

Shell beds occur extensively along the west coast from Corio Bay to Port Melbourne. They continue along the valley of Hovell's Creek 2 miles inland to Geelong Road (Hills, *op. cit.*), and were also recorded near Little River (Jutson, *op. cit.*).

From the R.A.A.F. base at Point Cook to near Skeleton Creek, further evidence of progradation is provided by the belt of sand ridges plastered along the coast.

Further north, a system of sand and shell ridges in the Altona–Williamstown district has been the subject for considerable discussion. Low dunes and swales run parallel to the coast for approximately 5 miles, and extend ½ mile inland to near Lake Truganina and Lake Altona. The ridges number seven or eight and are relatively low and broad as recorded by Hills (1940) who noted that "a ridge 4 chains wide is only 4 feet to 5 feet above the neighbouring swales". This contrasts with normal beach ridge morphology which is typically high compared with its breadth (Hills, *op. cit.*, p. 96). Jutson (1931) and also Pritchard (1910) in earlier examinations of the area believed the sand ridges could form at or near present sea level. Hills however, showed that although the ridges are now situated above high water, they had in part formed below high water. He concluded they were emerged submarine bars similar to those found on the sea floor in other parts of Port Phillip Bay.

Gill (1961) later described two separate formations—stratified marine shell beds overlain by superficial sands which form the ridges. He suggested their formation by slight eustatic fall in sea level accompanied by normal beach ridge building.

Link (1965) has recently postulated their development by the growth of sand spits from south to north accompanied by a fall in sea level.

In the region of the Yarra Delta, Gill (1956) has recorded marine faunas approximately 7½ miles upstream from Hobson's Bay in the valleys of both the Yarra and Maribyrnong rivers. In the latter region, marine shells occur *in situ* near Essendon to 4 feet above low water mark.

Additional evidence of emergence of the shores of Port Phillip Bay is provided by shore platforms now above sea level and by the common occurrence of inactive, vegetated cliffs. Shore platforms cut in both granite and Tertiary ferruginous sandstone were recorded by Hills (1940) to elevations of 3 feet above present high water. Near Dromana Bay and Frankston they are overlain by cobbles and shingles above the reach of present high tides and similar to cobbles found on present beaches in the area. On the south side of Picnic Point, Hampton, a raised shore platform in ferruginous sandstone occurs to 6 feet above present high water (Gill, 1950). This is backed by a former sea cliff now inactive and covered by younger detritus. Vegetated cliffs occur in most small bays on the eastern coast. These have been explained by a relative change in the level of sea and land which would allow erosion to continue on headlands and on areas opposite deep water, while reducing wave attack on shallow bay heads (Hills, *op. cit.*).

There is, therefore, ample evidence that the coastline in many places was once situated further inland on both the east and west side of the Bay. The change to its present position was not due to simple progradation but was accompanied by a change in the relative level of land to sea, of from 2 feet to 10 feet. The shells examined from the high level shell beds consist exclusively of living forms, and this, with the physiographic evidence cited above, established the Recent nature of the emergence as stressed by Hills, and later confirmed by radiocarbon dating.

From the differential elevation along and across an emerged shore platform in granite at Dromana Bay, of shell beds at Hovell's Creek, Sorrento, and Portarlington, Hills concluded that the emergence was at

least in part due to tectonic deformation, assisted by a Recent eustatic fall in sea level, the evidence of which exists in many places along the southern coast of Victoria (Hills, *op. cit.*, p. 100). Keble (1950) has invoked both tectonics and eustatics to explain—

1. warping of submarine terraces in Port Phillip (the existence of which have here been questioned), and
2. the recently emerged shell beds in Tootgarook swamp.

Gill (1956, 1961) regarded the shell beds of Port Melbourne, Altona and Hovell's Creek as due to eustatic sea level change accompanying the post-glacial climatic optimum. In support of this claim he has obtained radiocarbon dates from sites of emerged shell beds as follows:

wood fragment bored by *Teredo* in shell bed from Maribyrnong Valley near Essendon	4,820 (± 200)	
shells from emerged shell bed on right bank of Hovell's Creek near Geelong	5,620 (± 90)	
shells from Altona shell beds overlying basalt	5,560 (± 80)	(for early refs. see Dury, 1964).

Although the detailed effects of eustatics and tectonics are not yet clear, there is substantial evidence to support a relative change in level between land and sea in post-Pleistocene time. The widespread evidence of Recent emergence, although complicated locally by tectonic deformation, is consistent with a small mid-Recent change in sea level recorded by many workers from widely separated parts of the Australian and New Zealand coasts (Davies, 1959; Fairbridge, 1961; Jennings, 1961; Schofield, 1964).

Age and Depositional Environments.

Before the marine transgression, most of the area now occupied by Port Phillip Bay was a land surface. This surface is now represented by the older formation containing relict soil features recovered in cores through Recent sediment in the northern part of the Bay. In this formation, the zone with soil structures and plant rootlets represents the upper few feet of the former land surface. For this to be preserved, little erosion could occur during marine transgression. This is consistent with the flooding of a low-lying estuarine environment similar to that now found on the coast of Westernport Bay. In such an environment, shoreline deposition rather than erosion would occur. Extensive erosion would commence only when the transgression encroached to areas of moderate relief, by which time the combined effects of longer fetch and deeper water would permit wave attack on the coast.

Assuming that any Recent deformation in the centre of the Bay was small compared to present water depths, an estimate of the time at which marine flooding of the sunkland occurred can be made from the depths at which the older formation is now found in the Bay. The deepest occurrence so far obtained is in water 56 feet deep, $4\frac{1}{2}$ miles east of Point Cook (core 29). The older sediment was encountered here 6 feet below

the surface of Recent marine sediment, i.e. at 62 feet below sea level. The age of flooding of a surface at this level can be estimated from the established curves of the post-glacial sea level rise from other parts of the world (Fairbridge, 1961; Shepard, 1961; Curray, 1960). Sea level was approximately 60 feet lower than present during the period from 9,000 to 8,000 years ago. This correlates with the evidence of a eucalypt recovered *in situ* 63 feet below sea level during excavations for the Spencer Street bridge. Samples have yielded radiocarbon dates of 8,780 (± 200) and 8,300 (± 310) (Gill, 1955, 1956).

A single valve of *Anadara trapezia* found in core 18, located 2½ miles west-south-west from Sandringham Harbour in water 47 feet deep, was submitted for radiocarbon dating. This core consists of 76 cms. of Recent calcareous sands and clays overlying 10 cms. of stiff consolidated sandy clays of the buried soil. The molluscan valve selected for dating was located at 73 cms. in the core, 3 cms. above the contact with the buried soil, and yeilded a radiocarbon age of 5,990 (± 160) (N 155). This is consistent with the age of the marine transgression across the soil surface as estimated from the known rates of sea level change in post-glacial time.

Assuming that transgression in this area occurred approximately 8,000 years ago, the rate of later marine deposition in the northern part of the Bay can be determined from the thickness of Recent marine sediments overlying the buried soil. This varies in the north-central part of the Bay from 3 feet to more than 8 feet corresponding to sedimentation rates of approximately 0·4 feet to 1 foot per 1,000 years.

From the foraminiferal evidence quoted earlier, the environment in which deposition occurred after the transgression 8,000 to 9,000 years ago, was of higher salinity than in the same area today. The Recent decrease in salinity may be due to an increase in the relative percentage of fresh water to oceanic water in the Bay brought about by:

1. A Recent increase in the discharge of streams flowing into the Bay, resulting from increased precipitation.
2. A decrease in the evaporation rates within the Bay.
3. A restriction of the inward flow of oceanic water by a Recent narrowing of the entrance to Port Phillip Bay (cf. Hall, 1909, p. 77).

The aeolianite barrier now forming the Nepean Peninsula, was already in existence before the formation of Port Phillip Bay. The entrance to Port Phillip Bay, cut through the aeolianite, is still actively eroding. Contrary to the suggestion by Hall, the entrance has probably never been wider than in its present form.

On the other hand, independent evidence exists for a mid-Recent period of mild aridity 6,000 to 4,000 years ago with lower rainfall and higher evaporation rates than at present. The age of the climatic optimum is in close agreement with the estimated age of sediments deposited during the period of high salinity. The close correlation between these two events suggests that salinity changes were climatic effects brought about by changes in temperature, evaporation rates and precipitation in the Port Phillip area.

PRESENT ENVIRONMENT.

Sediment Transport and Coastal Changes.

The physiographic variations between the east and west coasts of Port Phillip Bay depend not only on lithological and structural differences but also on the direct influence of the present system of currents, winds and waves in the area. These determine the patterns of erosion, transportation and deposition.

Sediment is transported in the shallow marine environment mainly by two types of currents:—

(*a*) tidal currents and

(*b*) wave generated currents.

Although little detailed information is available on water circulation patterns due to either of these processes in the Bay, some general observations can be made.

In the south near the Nepean shoal, the influence of tidal currents is dominant. The pattern of scoured channels and shifting shoals is controlled almost entirely by the ebb and flood tidal streams, which at Port Phillip Heads reach velocities to 8 knots (see The Australia Pilot, 1956). Moreover, the effects of waves and wave-generated currents is minimized near the entrance to Port Phillip Bay by the protection offered from all but northerly and north-westerly winds.

In the northern and central part of the Bay, the combined effects of exposure to winds from all directions, long fetch, and relatively deep water, permit the development of high wave energy. Tidal currents are weak and thus waves and wave-generated currents control sedimentation. The magnitude and rapidity of coastal changes, resulting from changes in winds and wave conditions, was spectacularly demonstrated during July, 1964, when a series of intense cyclonic depressions passed south of the Victorian coastline. These caused steep pressure gradients over southern Victoria with gale force winds often reaching more than 30 knots, and generated steep storm waves which caused extensive damage to the eastern shores of Port Phillip Bay.

The approach of each depression from the west was preceded by strengthening northerly winds reaching gale force. The winds backed to moderate westerlies and finally to weaker southerlies as the depressions moved east away from the coast into the Tasman Sea.

Storm waves and strong rip currents generated by northerly gales stripped sand off the beaches, especially off those oriented obliquely to the direction of wave fronts and exposed to long fetch as on the eastern and south-eastern sides of the Bay. At Fisherman's Beach near Mornington, erosion on the northern end completely stripped sand back to the sea wall protecting the cliffs. Simultaneous deposition occurred at the southern end where the beach prograded seawards more than 50 feet.

At Balcombe Beach near Mt. Martha, similar changes occurred. A sandy beach to 5 feet deep and 100 feet wide was stripped for a length of nearly 600 feet from the northern end, while simultaneous deposition occurred further south. Boatsheds were undermined and many completely

destroyed. The beach was cut back to the foot of the cliff and active erosion was initiated in freshly exposed Tertiary lignitic clays. Progradation on the southern end of the beach resulted in the deposition of a cuspate foreland 200 feet wide, south of the mouth of Balcombe Creek which was blocked by the deposition of a high berm.

On the coast between Mordialloc and Frankston extensive erosion occurred near Seaford. This was accentuated by the presence of groynes which impeded the littoral drift, thus concentrating erosion on the downdrift side. On the immediate downdrift side of a groyne, the beach was eroded back 50 feet to the backshore region, accompanied by a lowering of more than 5 feet. Cliffs up to 10 feet high were cut in the foredune behind boatsheds on the foreshore, many of which were undermined and destroyed. Eroded sands were deposited off-shore, producing shoals separated by rip channels which remained visible from the beach for more than two days.

After a northerly storm on July 1st and 2nd, weaker southerlies and south-westerlies initiated the return of sand to the erosion sites by on-shore drift. But further severe depressions followed throughout July and early August, and the events of the early storms were repeated. The climax was reached on July 12th when the atmospheric pressure dropped to 28·96 inches (980·6 millibars), the lowest July pressure ever recorded at Melbourne, and the lowest pressure since December, 1863. This was accompanied by gale force north-westerly winds with gusts over 60 m.p.h.

By late August, much of the sand had returned to areas previously stripped by erosion. By December, sand had been restored almost equally along the beaches. In a later aerial inspection during February, 1965, the winter pattern at Fisherman's Beach and Balcombe Bay was reversed with greatest sand accumulation on the northern ends of beaches. Further north at Seaford, a broad sandy beach had built out 150 feet in front of the foredune cliffs developed during the previous winter. This was accompanied by the accretion of sand to depths of 5 feet over the August profile.

Although the winter of 1964 was in some ways exceptional (July was the windiest month ever recorded at Melbourne), nevertheless the pattern of coastal changes observed from July, 1964, to February, 1965, corresponds in type if not in magnitude, to the winter-summer changes of a normal year.

A similar pattern has been observed in the migration of the off-shore bars between Mordialloc and Frankston over the same period. In July, the inner bar was irregular with oblique small bars oriented in a south-south-westerly direction and often joining the beach. These had a steep sand-slip face on the south-eastern side and were adjusted to waves from the north. Their form indicated movement from north to south. Near Seaford, both inner and outer bars were irregular with lobate bars separated by rip channels. By February, 1965, bar patterns were more regular with both inner and outer bars continuous and parallel for long distances along the coast. Moreover, minor oblique bars linking the inner bar with the beach were changed in form and orientation. Their trend was changed to north-west–south-east; the slip-face was developed on the north-east, indicating northerly migration in response to southerly or south-westerly waves.

The rapidity of bars changes near Seaford has been further confirmed by local fishermen and has resulted in several drownings due to the migration of shoals and rapid changes in the location of rip channels.

In a comprehensive study of the littoral drift patterns in the north-east of Port Phillip Bay, Baker (1963, 1964) was able to estimate the rates of sediment movement along the shore. Pyrite cinders dumped at low water mark off Head Street, Brighton, were rapidly dispersed by waves produced by strong northerly winds, and were carried south 7 miles to Rickett's Point in 62 days (Baker, 1964, Fig. 9). Moreover, off-shore sampling showed that material transported along the coast was kept close in-shore. Baker's conclusion indicates a net north to south movement for the period of the test—180 days from August, 1963, to February, 1964. During this period minor reversals occurred from south to north in response to changes in winds and wave directions.

On the east coast, observations on the same day sometimes show different drift patterns on different parts of the coastline. Accumulation on the northern sides of groynes and artificial structures was observed on the northern and eastern sides of the Bay during an aerial inspection in August, 1964. But further south in the Dromana–Rye area on the same day greatest accumulation was on the southern side of groynes (Baker, *op. cit.*).

On the west coast, net sediment movement occurs from south to north. This is confirmed by (*a*) the construction of sand barriers or spits on the southern side of streams entering the Bay at Skeleton Creek, Kororoit Creek and Little River and (*b*) the accretion of sand only on the southern sides of drains projecting across the beach and acting as groynes near the Metropolitan farm, south of the Werribee River. The largest quantities of sand on the west coast occur in the region between Point Cook and Williamstown, where extensive sand ridges have developed. Accumulation in this area is assisted by the dominant effect of south to north drift. Deposition here is cumulative since the protection afforded from northerlies by the coastal orientation permits little drift in the reverse direction.

Natural headlands often protect beaches by impeding the sediment movement from one part of the coast to another. Thus pocket beaches, as at Fisherman's Beach, owe their protection to the projecting headlands at the ends of the beach. The more indented areas such as near Mordialloc and Dromana, protected on the north by projecting headlands facing relatively deep water, act as sand traps. Some sand moves north to south past the headlands but movement in the reverse direction is prevented by the nature of the submarine topography and the trend of the coast. A progressive accumulation of sand occurs in these areas with continuous depletion from the thin pocket beaches located along the north-eastern section of the coastline from St. Kilda to Rickett's Point, and in the south-east from Frankston to Mt. Martha. In these areas, only limited quantities of sand are available, usually in a thin veneer covering abraded rock platforms. The sand shortage is further aggravated by some of the artificial structures in the area, e.g., breakwaters at Sandringham and Brighton, which have trapped large quantities of sand which would otherwise be available for distribution along the coast.

Little material is available to replenish beaches lost by natural or artificial causes (Baker, 1963, 1964). Some have already been completely destroyed as along Beach Road, Sandringham. The conservation of remaining sediment suitable for beach building in these areas is a matter of public concern.

Wind Statistics.

Detailed wave records are not available for Port Phillip Bay, but information on the distribution of wave energy may be obtained from analyses of wind records from recording stations near the coast. Wind statistics are available from the R.A.A.F. aerodrome at Laverton on the west coast, from two stations in Melbourne—the Flagstaff Observatory in West Melbourne, and the Commonwealth Bureau of Meteorology in Victoria Street—and from the C.S.I.R.O. Division of Meteorological Physics at Aspendale on the east coast. These stations are suitably situated to obtain representative figures for winds on the eastern, western and northern sides of the Bay. Some variations exist in the wind patterns at different stations, e.g., the southerlies recorded at Melbourne in summer often have a more westerly component at Aspendale. However, the wind systems at the three stations are sufficiently consistent to serve as a basis for discussion of general wind patterns around the coastline of Port Phillip Bay.

In a complex system involving winds, waves and sediment transport, some empirical relationships have been established. Steep and high storm waves generated by strong winds, erode sediment off the beaches and deposit it in the off-shore region. Smaller waves generated by winds of intermediate velocities transport sediment back onto the beach and deepen the off-shore region. This pattern established by Bascom (1954) and Rector (1954) was observed in the coastal changes on the eastern beaches in July–August, 1964. Waves generated by low velocity winds, even if they persist for long periods, transport comparatively small quantities of sediment and may be omitted from consideration.

To evaluate the overall effects of winds and waves on coastal sediment movement, variations in the frequencies, velocities and distributions of the wave-generating winds must be considered.

The monthly percentage frequency distributions for winds at Melbourne and Aspendale are shown in Figs. 8 and 10.

Monthly, seasonal and annual means for Melbourne and Laverton are shown in Table II. Monthly means for Aspendale are shown in Table III.

In the data from all stations, a strong seasonal variation in wind direction is evident at different times of the year. Northerlies and north-westerlies are prevalent in autumn, winter and spring, but southerlies and south-westerlies are prevalent in summer, especially in the afternoon readings (cf. Fig. 8A and B). Easterlies however, are subordinate to winds from other directions throughout the year. Similar seasonal variations in wind directions were recorded by Neumayer (1867, p. 15) who noted that for the period April 20th to September 14th, the mean direction was northerly (31°). But from October 15th to April 5th, the mean direction was south–south-westerly (196°).

TABLE II.

—	Mean Direction Melbourne † 1858–63		Vector Mean, Laverton * 1959–63		
			Direction		Knots
March	SSW	207	WNW	285	2
April	NW	305	NNW	329	3
May	NNW	345	NW	309	4
AUTUMN	NW	324	NW	313	3
June	N	8	NNW	332	3
July	NNW	347	NW	326	5
August	NNW	337	NW	317	5
WINTER	N	351	NW	324	4
September	NNW	328	NW	312	4
October	W	279	WNW	295	3
November	SW	235	WNW	285	4
SPRING	WNW	286	WNW	298	4
December	SW	224	WSW	255	2
January	SSW	208	WSW	254	1
February	SSW	195	WSW	252	2
SUMMER	SSW	207	WSW	254	1
ANNUAL	NW	307	NW	306	3

Monthly, seasonal and annual mean values for winds recorded at Flagstaff Hill, Melbourne, and Laverton during the periods 1858–63 and 1959–63, respectively.

* From Neumayer, 1867.

† From Maher and McRae, 1964.

TABLE III.

MEAN VELOCITY IN KNOTS.

Direction in degrees	January	April	July	October
30	4·9	4·1	7·8	5·1
60	2·9	2·5	3·4	3·1
90	4·9	4·1	6·7	4·6
120	6·4	6·6	6·6	7·0
150	5·0	4·8	5·6	4·4
180	6·5	5·6	7·1	6·4
210	8·3	7·7	8·2	8·4
240	6·9	7·6	8·9	7·9
270	7·0	9·9	10·4	10·9
300	7·7	8·2	8·3	10·0
330	7·4	7·1	7·9	8·5
360	9·6	9·1	10·1	10·6

Monthly mean velocities of winds to 12 points of the compass recorded at Aspendale for the years 1955–64 inclusive. Note the consistently high velocities of westerlies and northerlies compared with easterlies.

(Computed from data supplied by C.S.I.R.O. Division of Meteorological Physics, Aspendale.)

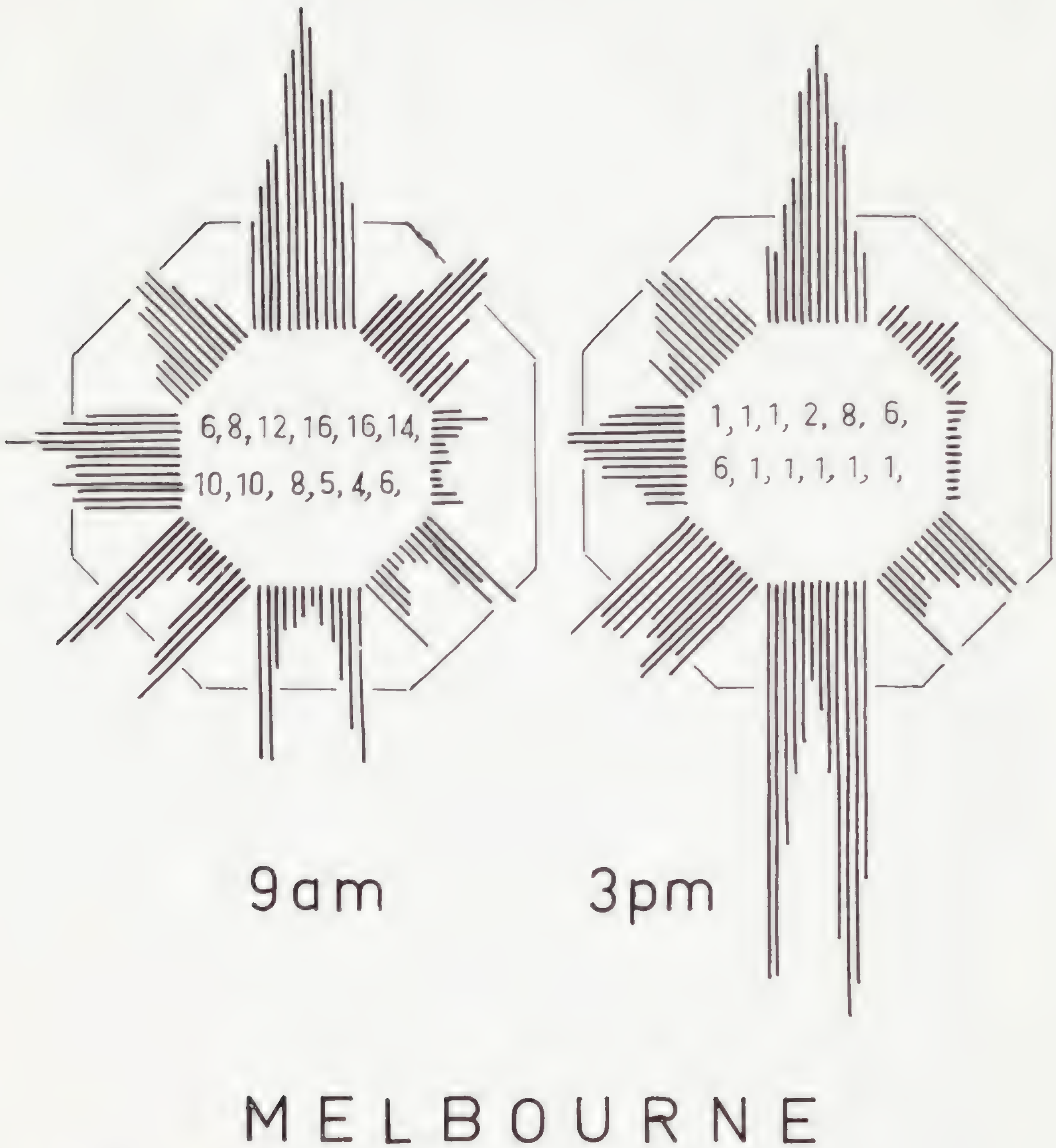


Fig. 8. Wind roses showing monthly percentage frequency distribution of wind directions to eight points of the compass recorded at Melbourne, by the Commonwealth Bureau of Meteorology.

The sides of the octagons face toward the cardinal and semi-cardinal points. Projecting from each side are twelve columns representing the twelve months of the year, and the lengths of the columns are proportional to the percentage frequencies of winds from the given direction in the successive months, working round clockwise from January to December. The outer octagons are separated from the inner octagons by a distance representing $12\frac{1}{2}\%$. The percentage frequency of calms for the 12 months is shown by figures within the octagons. (From Bureau of Meteorology, Bull. No. 1, 1964.)

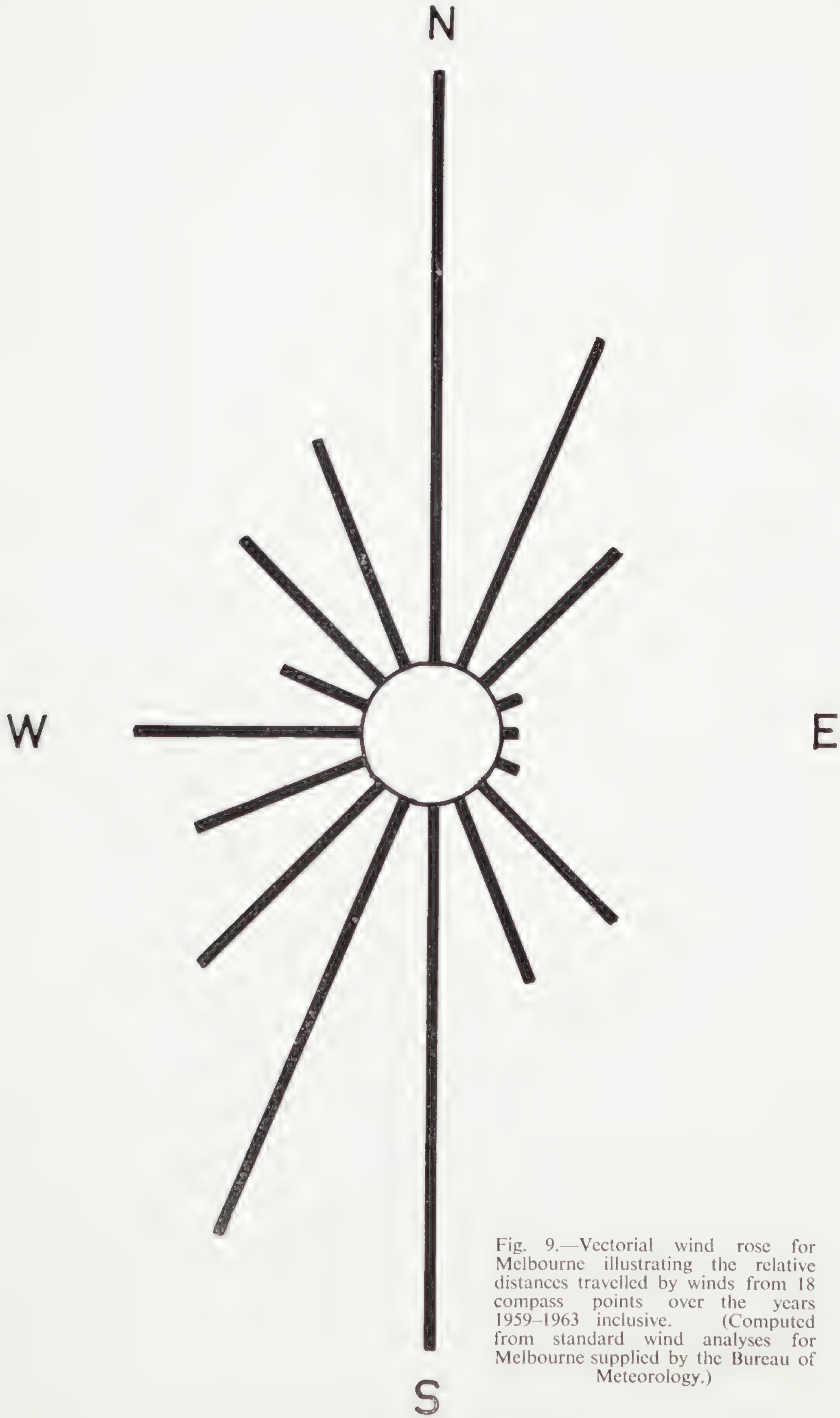


Fig. 9.—Vectorial wind rose for Melbourne illustrating the relative distances travelled by winds from 18 compass points over the years 1959–1963 inclusive. (Computed from standard wind analyses for Melbourne supplied by the Bureau of Meteorology.)

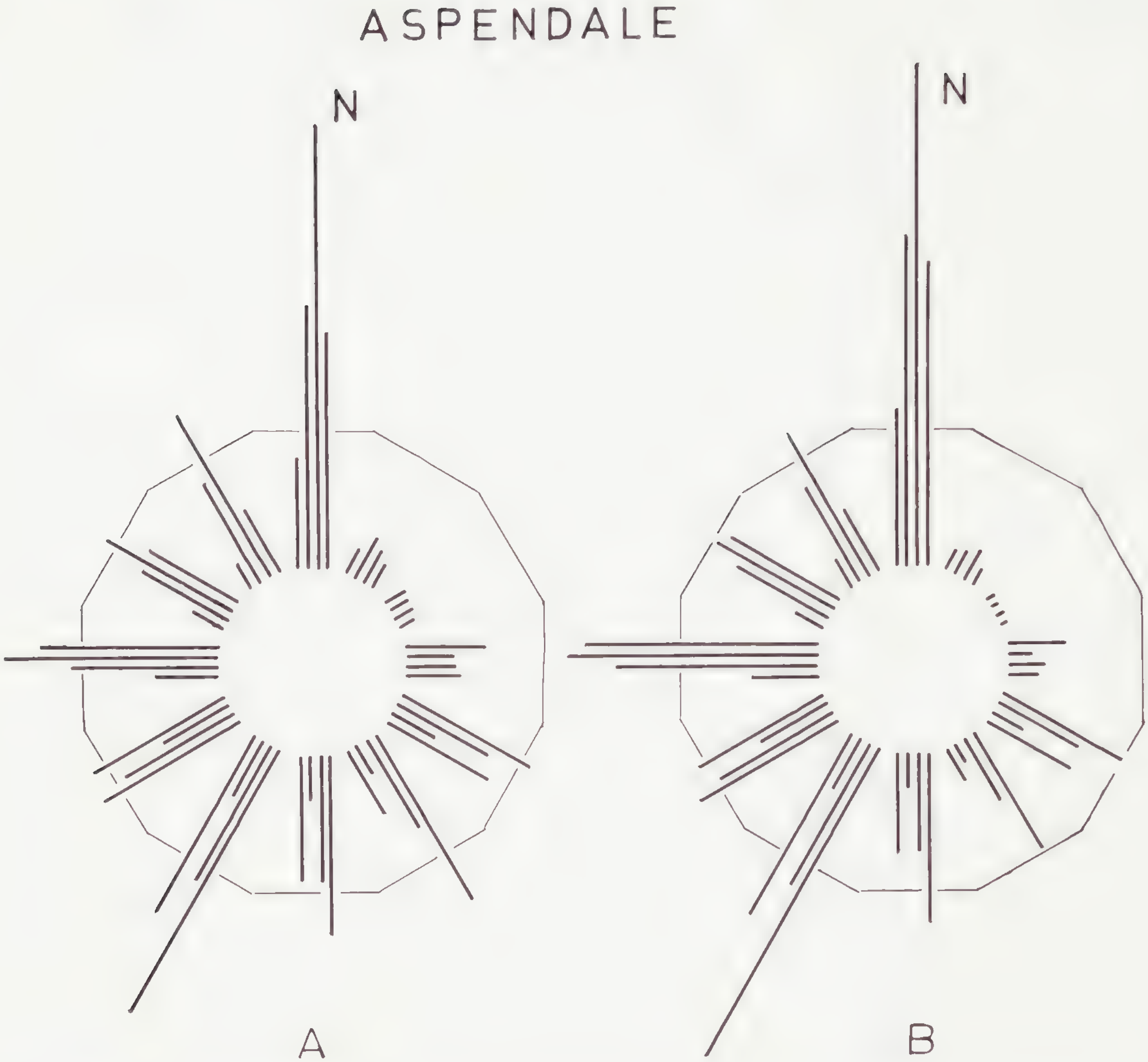


Fig. 10.—Wind roses showing (A) the percentage frequency distribution, and (B) the percentage vector distribution of winds to 12 points of the compass recorded at Aspendale for the months January, April, July and October, 1955-64 inclusive, at two-hourly intervals.

The magnitude of percentage frequencies and vectors is represented by the proportional lengths of columns in a given direction in successive months working clockwise from January to October.

The distance from the outer to the inner polygon represents 10%.

(Computed from data supplied by C.S.I.R.O. Division of Meteorological Physics, Aspendale.)

A relative measure of the variation in annual wave energy distribution with direction is obtained by combining wind frequencies and velocities to determine the vector distribution of winds. This has been determined from data obtained at Melbourne (Fig. 9) and at Aspendale (Fig. 10B). Northerlies and southerlies have a clear overall dominance over winds from other directions, while the relative insignificance of easterlies is emphasized.

In the high velocity group, gales from the north are most frequent. Of the total number of gales recorded at the Flagstaff Observatory for the years 1859 to 1863, 79 per cent. had a northerly component (cf. also monthly mean velocities from Aspendale, Table III).

Gales occur throughout the year, but from the Flagstaff records, they are most common in spring and summer (Table IV.). The monthly mean velocities however, are highest during winter (cf. Tables II. and III.).

There is, then, not only a 180° change in dominant wind direction from summer to winter, but also an important variation in wind speed with direction; northerlies are composed mainly of high velocity winds and the southerlies of relatively low velocity. In winter, when the southerly influence is weak, the northerly gales dominate the pattern of coastal sediment movement. In summer, the eroding effects of the northerly gales are more than off-set by the prevalent southerlies which not only reverse the direction of littoral drift but also produce on-shore drift.

Sediment movement and the coastal changes produced, are most evident on parts of the coastline oriented obliquely to the direction of the prevailing wave fronts. Northerlies produce waves oblique to all parts of the Port Phillip coastline, except to parts of the Bellarine and Nepean Peninsulas. Southerlies similarly, produce waves oblique to all sections of the coast, except for short segments in the north-east from Beaumaris to St. Kilda, for the Port Melbourne–Altona area, and for the northern shores of Corio Bay. Westerlies and easterlies on the other hand, both produce wave fronts approximately parallel to the configuration of the shores on opposite sides of the Bay. But while northerlies, southerlies and westerlies are important at various times of the year, easterlies remain relatively unimportant throughout the year.

Thus an important variation exists in the wave energy distribution around the coast of Port Phillip Bay. The western coast, protected by limited fetch from northerly, westerly and southerly winds, is exposed only to low energy easterlies and south-easterlies. In contrast, the eastern coast is exposed to high energy waves from the north, west and south. Erosion, sediment transport and deposition is therefore more active on the eastern coast, and more complex than on the west.

The general pattern of sediment movement from St. Kilda to Mt. Martha is determined by coastline orientation and the occurrence of northerly, westerly and southerly winds. The seasonal changes in wind frequency and strength produce erosion, with north to south littoral drift during winter and reversal of the net drift direction with progradation during summer. Off-shore easterlies cause little sediment movement and favour deposition.

The coast from Dromana to Point Nepean, however, does not reflect the same pattern due to its different orientation. It is adjusted at right angles to the direction of maximum fetch and exposed to northerlies and north westerlies but protected from both southerlies and easterlies. It is a zone of sediment accumulation by north to south and west to east movement.

TABLE IV

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	Total
Summer					1		1		4		4		29				41
Autumn									1		6		20		6		35
Winter									2		1		11	1	4		21
Spring			2				2		14		10	1	16		14		59
Totals			2		1		5		21		21	1	76	1	24		155

Seasonal distribution of gales greater than 25 knots recorded during the years 1858-64 inclusive at the Flagstaff Observatory, Melbourne.

(Adapted from Neumayer, 1867, Appendix p. VII.)

TABLE V

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	Total
December						1		1									2
January				1							1		1				3
February						1								2			3
SUMMER																	8
March																	0
April								1			1	1	1	1			5
May							1				1	1	2		1		6
AUTUMN																	11
June				1									2	1			4
July							1							1			2
August													1				1
WINTER																	7
September						1	1	1					1				6
October							1						2	1			4
November							1						1				2
SPRING																	12
Totals	0	0	0	2	0	1	5	1	0	0	3	1	12	6	1	0	38

Showing the monthly distribution of gales (greater than 30 knots), for the five years 1959-63 inclusive. Computed from standard wind analyses for Melbourne, supplied by Commonwealth Bureau of Meteorology.

TABLE VI.

QUADRANTS IN WHICH WINDS WERE RECORDED.

—	0°–90° (NE)	90°–180° (SE)	180°–270° (SW)	270°–360° (NW)
January	3	9	17	24
April	0	1	26	16
July	3	0	11	48
October	2	9	54	61
4 month total	8	19	108	149

Occurrence of winds greater than 20 knots, recorded at Aspendale during the period 1955–64 inclusive. Readings at two hourly intervals.

Note the importance of north-westerlies and south-westerlies over easterlies.

(From data supplied by C.S.I.R.O., Division of Meteorological Physics.)

CONCLUSIONS.

The geomorphic sequence in the development of Port Phillip Bay may be summarized as below:

Palaeozoic to Tertiary movement on Rowsley and Selwyn's Faults forming the Port Phillip sunkland.	
Outpouring of (?) Late Pliocene–Early Pleistocene Newer Basalt of Western Plains near Geelong.	Post-Tertiary early-Quaternary climatic deterioration. Early glacio-eustatic sea level changes.
Incision of ancestral rivers of Moorabool, Barwon and Leigh Rivers on margins of basalt flows.	Period of (?) aridity with formation of siliceous dunes at Brighton, Frankston and Drysdale.
Late Newer Basalt flows near Geelong, infilling ancestral rivers of Moorabool, Barwon and Leigh.	Mid-Pleistocene sea level changes. Calcareous dunes built during high sea level; soils formed during low sea levels.
Incision of present Moorabool, Barwon and Leigh Rivers.	
Faulting on Rowsley and Barrabool Hills Faults, Lovelybanks and Curlewis Monoclines.	Movement on Selwyn's Fault with uplift on Mornington Peninsula, and downwarping of sunkland and early aeolianite.
Non-marine limestone deposited in basin formed in fault-angle depression near Geelong.	Further glacio-eustatic fluctuations with alternate periods of dune building and soil formation. Late Pleistocene downwarping. S.L. fall to –300 feet during last glaciation.
Post-glacial rise in sea level inundating Yarra floodplain and Corio Basin. Aggradation in rivers entering bay. S.L. rise continued to 6–10 feet above present. Cliffs cut in dunes and marine invasion behind line of Pleistocene aeolianite ridge. Salinity higher than present.	
Mid-Recent fall in S.L. exposing Recent shell beds, complicated in places by tectonic deformation. Formation of coastal sand ridges on west. Progradation in Carrum and Tootgarook Swamps on east. Drop in salinity. Erosion and deposition to present.	

Many of the geomorphic differences between the east and west coasts of Port Phillip Bay are explained by the asymmetrical distribution of wave energy determined by the local wind patterns, and coastal configuration. Thus the different depths at which breaks occur in the near-shore topographic profiles in Fig. 4 are due to variations in wave energy from east to west. On the east coast, sands are shifted to greater depths than on the west, which rarely experiences high energy storm wave conditions.

Larger quantities of sediment are moved along the east coast than on the west. The view expressed by Jutson (1931) that the east coast is an area of erosion while the west is an area of deposition is not in complete agreement with the present evidence. Taken section by section, the east coast is almost equally divided between areas of erosion and deposition. But on the west, little erosion occurs, so that deposition appears to dominate. Moreover, little evidence exists for sediment transport across the Bay except for fine silts and clays which travel in suspension. In cores, the thickness of Quaternary silts and clays on the eastern region is as great as on the west.

The few erosional landforms on the west coast provide further evidence of the low energy available to this area. Although basalt forms well-developed shore platforms on exposed parts of the Victorian coast, only one small elevated platform is present on the west coast of Port Phillip near Williamstown.

Depositional features also vary according to the available coastal energy. East coast beaches are in places broad, deep, well-sorted and adjusted to directions of maximum fetch, while those in the west are narrow, thin and poorly sorted. The combined effects of geology and climate explain these and other elements of geomorphic asymmetry from east to west which are summarized in Table VII.

From the available wind data, field observations and from aerial photographs, the complex patterns of sediment movement along the coast may be summarized as follows:

1. On the west coast, movement is mainly south to north due to the dominant influence of southerlies over winds from all other directions.

2. Movement on the east coast is complex, but on beaches with a north-south alignment, an overall seasonal alternation exists. North to south movement occurs in winter controlled by dominant northerlies, with a south to north movement in summer controlled by southerlies.

3. The larger coastal indentations on the east coast act as sand traps. Sands once transported south past Rickett's Point and Martha Point cannot move back in the reverse direction. This results in progressive infilling and progradation in the indented areas at the expense of sediment removed from headlands or beaches further north.

4. Artificial structures have in places trapped sediment which would otherwise be available to replenish areas subject to erosion.

The present environment of Port Phillip Bay has developed by a complex history in which climate, lithological variations, tectonic deformation and eustatic sea level changes have all played an important part. This environment is now undergoing further change both on the sea floor and along the coastline due to human interference resulting from economic, residential and recreational pressures. Some irreversible changes have already occurred. Conservation of the remaining resources of Port Phillip Bay requires a greater understanding of the magnitude and complexity of the processes responsible for its development and for maintaining its natural equilibrium.

TABLE VII.

COMPARISON OF THE GEOMORPHIC FEATURES DEVELOPED ON THE EAST AND WEST COAST OF PORT PHILLIP BAY.

	West Coast.		East Coast.
	Bellarine Peninsula		
Off-shore depth ..	Intermediate	Very shallow ..	Relatively deep
Average gradient to 10 fathoms contour	..	1 in 500 ..	1 in 250
Relief on land	Moderate ..	Very low ..	Moderate to high
Main rock types..	Tertiary sands, clays and Older Basalt	Newer Basalt and Quaternary alluvium	Palaeozoic granitic rocks, Tertiary sands, clays and Older Basalt, Pleistocene aeolianite, Quaternary alluvium
Cliffs	Common intermediate height	On small length of coast and low	Common on areas of moderate to high relief, intermediate to high
Shore platforms ..	Rare	Very rare ..	Common on headlands
Beaches	Narrow, shallow mud and sand	Narrow, shallow mud and sand	Broad and deep sandy beaches in large indentations; shallow sand on smaller bay-head beaches
Off-shore bars	Rare ..	Small, regular and extend long distances	Larger, very irregular in places. Occur only opposite larger sandy beaches
Coastal sand ridges	Portarlington, Point Lonsdale	Altona—Point Cook	Rare
Littoral sediment movement	..	South→north small quantities, little infilling	North⇄south large quantities resulting in considerable infilling

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Dr. G. Baker and Mr. A. Link kindly read and criticized the manuscript.

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PLATE I

Photograph taken from a meteorological balloon at an altitude of 95,000 feet over Port Phillip Bay at 2.15 p.m. on 1st February, 1961.

The balloon was situated slightly east of the centre of Port Phillip and portion of the camera assembly obscures the area near Frankston. Coverage extends from the Otway Ranges in the far west to Westernport Bay and Anderson's Inlet in the east.

Note the partial cloud coverage which has been spread inland from the coast by the development of an afternoon sea breeze.

(Photo by courtesy of Prof. V. D. Hopper.)

PLATE II.

Photograph of a block model of South-Central Victoria in the Department of Geology, University of Melbourne, showing the topographic relief and drainage in the vicinity of Port Phillip and Westernport Bays.

Note the linear escarpments corresponding to major tectonic structures (see Hills, 1951, p. 161).

PLATE III.

Fig. 1

Fig. 2.

Fig. 1: View along the north eastern shore of Port Phillip Bay with Rickett's Point in the foreground and Black Rock in middle distance. Note the irregular nature of the coastline with headlands protected by shore platforms cut in Pliocene ferruginous sandstone and exposed here in the intertidal zone.

(Photo—J.M.B. 12 2 65.)

Fig. 2: View looking north along Mornington Peninsula with Fisherman's Beach in foreground and Mornington pier in middle distance. Ferruginous Baxter Sandstone forms the resistant cliffed headlands with sand deposition in the protected bays. The outline of Fisherman's Beach shows maximum sand deposition in the north with south to north littoral movement impeded by groynes in the centre. This summer pattern is the reverse of that developed in the previous winter when erosion in the north was accompanied by deposition in the south where the beach prograded 130 feet beyond its present position.

(Photo—J.M.B. 12 2 65.)

PLATE IV.

FIG. 1.

FIG. 2.

FIG. 1: Aerial view looking south along the east coast of Port Phillip Bay towards Frankston. Two off-shore bars developed in the foreground near Seaford pass south to three bars near Frankston pier. Waves from the south-west break obliquely over the bars producing south to north littoral drift.

(Photo—J.M.B. 12/2/65.)

FIG. 2: Aerial view along the ocean beach near Sorrento towards Point Nepean in the west. Broad horizontal shore platforms in Pleistocene aeolianites are developed in the intertidal zone backed by steep cliffed headlands with sandy beaches developed in protected bay-heads. The entrance through Port Phillip Heads is visible in the background.

PLATE V.

FIG. 1: Oblique aerial view looking north-east across Balcombe Point towards Balcombe Beach, Mornington. In the foreground, steep cliffs now largely vegetated, are developed in Mt. Martha granodiorite with small shore platforms emerging above low water. The mouth of Balcombe Creek in the background is blocked by a summer berm. The broad sandy beach in the protected embayment has prograded under the influence of summer waves.

(Photo—J.M.B. 12/2/65.)

FIG 2: View from a point north of the Werribee River looking across the west coast basaltic plain north-east towards Point Cook. Note the irregular outline of the coast with poorly developed beaches. Shallow off-shore bars remain parallel to the coast for more than 4 miles to Point Cook in the background. Waves breaking over the bars were generated by winds to 25 knots from the south.

(Photo—J.M.B. 4/2/65.)

PLATE VI.

FIG. 1: A recent cuspate foreland developed by sand deposition in the low energy zone behind the solid portion of the breakwater at Brighton harbour. Erosion of beaches has occurred on both the north and south sides of the breakwater. Note the adjustment of the recurved spit to waves from the south passing through the open piled eastern end of the harbour.

(Photo—J.M.B. 12/2/65.)

FIG. 2: Sandringham harbour protected by a solid breakwater built in 1950. Extensive deposition of sands and silts has occurred in the harbour since the breakwater construction. The former position of the shoreline is visible in top right, where steep cliffs and a row of boat sheds are now separated from the shore by more than 100 yards of recently deposited sand. Sand has been stripped from beaches along the north coast, which is now protected by a sea wall. Active erosion is occurring between the eastern end of the sea wall and the western edge of sand deposition.

(Photo—J.M.B. 12/2/65.)

PLATE VII.

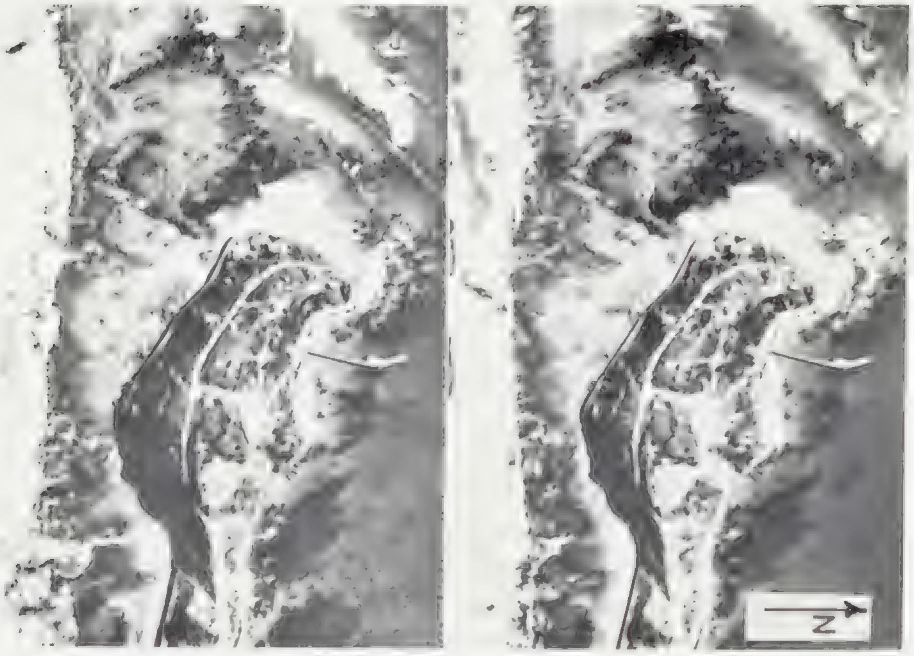


FIG. 1: Vertical stereo-pair showing the western end of the Nepean Peninsula with the high energy coastline on the left and Port Phillip Bay on the right.

A broad horizontal shore platform cut in Pleistocene aeolianite extends for 300 yards beyond the end of cliffed dunes on the ocean side but dies out inside Port Phillip Bay.

Ocean swell entering Port Phillip Heads is refracted through nearly 180° around the tip of Point Nepean.

(1" — 10 Chns. Photo by courtesy Lands Dept. Vic. 29/7/60.)

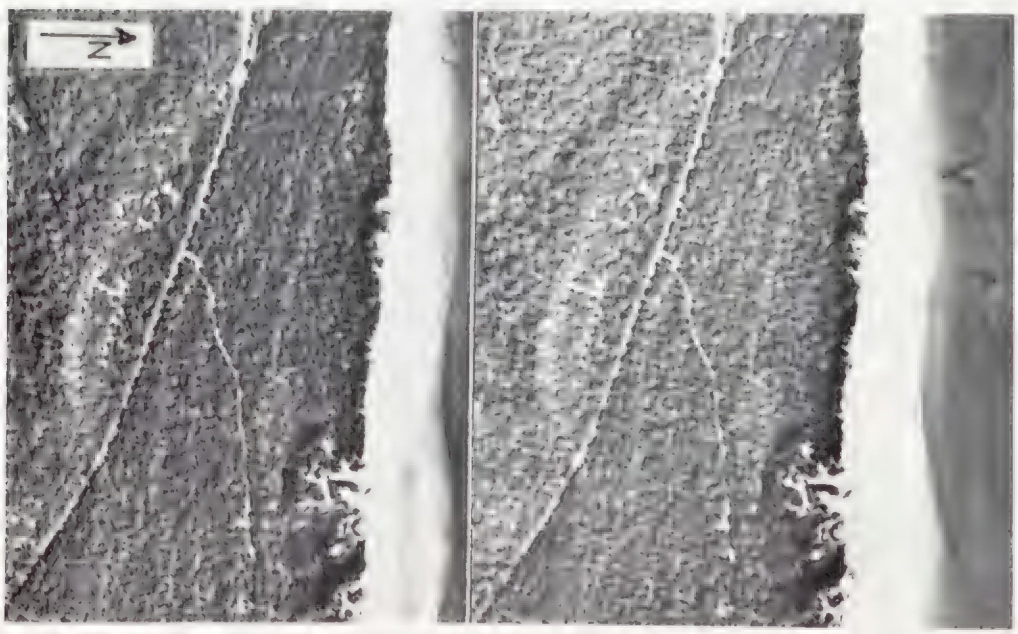


FIG. 2: Vertical stereo-pair of beach ridges developed near Observatory Point 1 mile east of Point Nepean. A vegetated cliff on the left represents a post-glacial strandline. Progradation by beach ridge building was accompanied by a slight relative drop in sea level to near its present position.

(1" — 10 Chns. Photo by courtesy Lands Dept. Vic. 29/7/60.)

PLATE VIII.

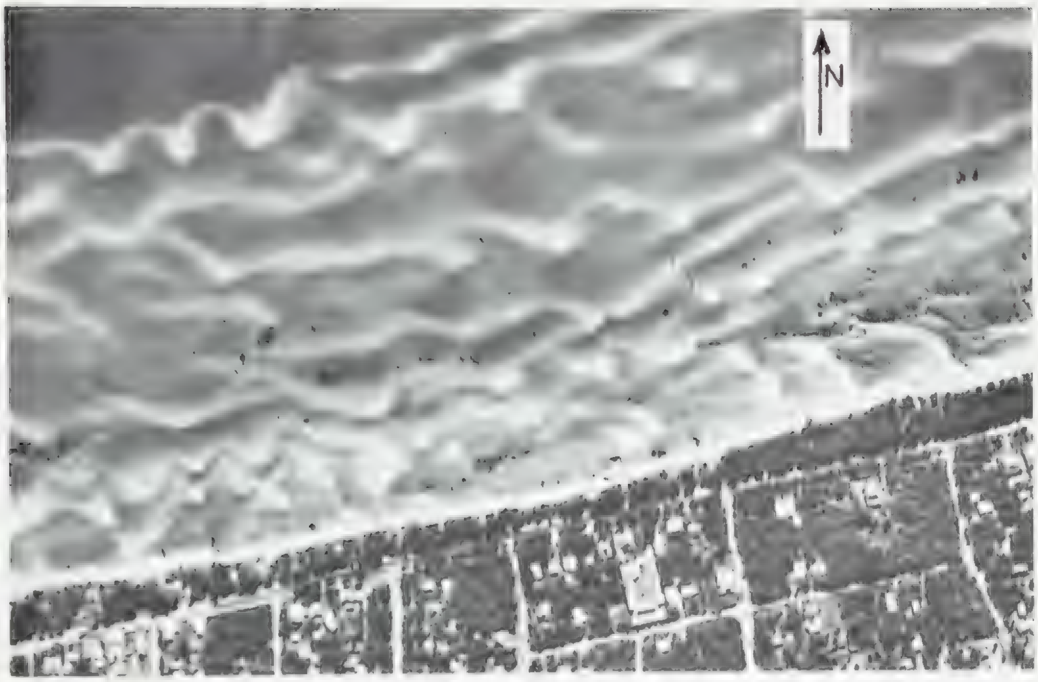


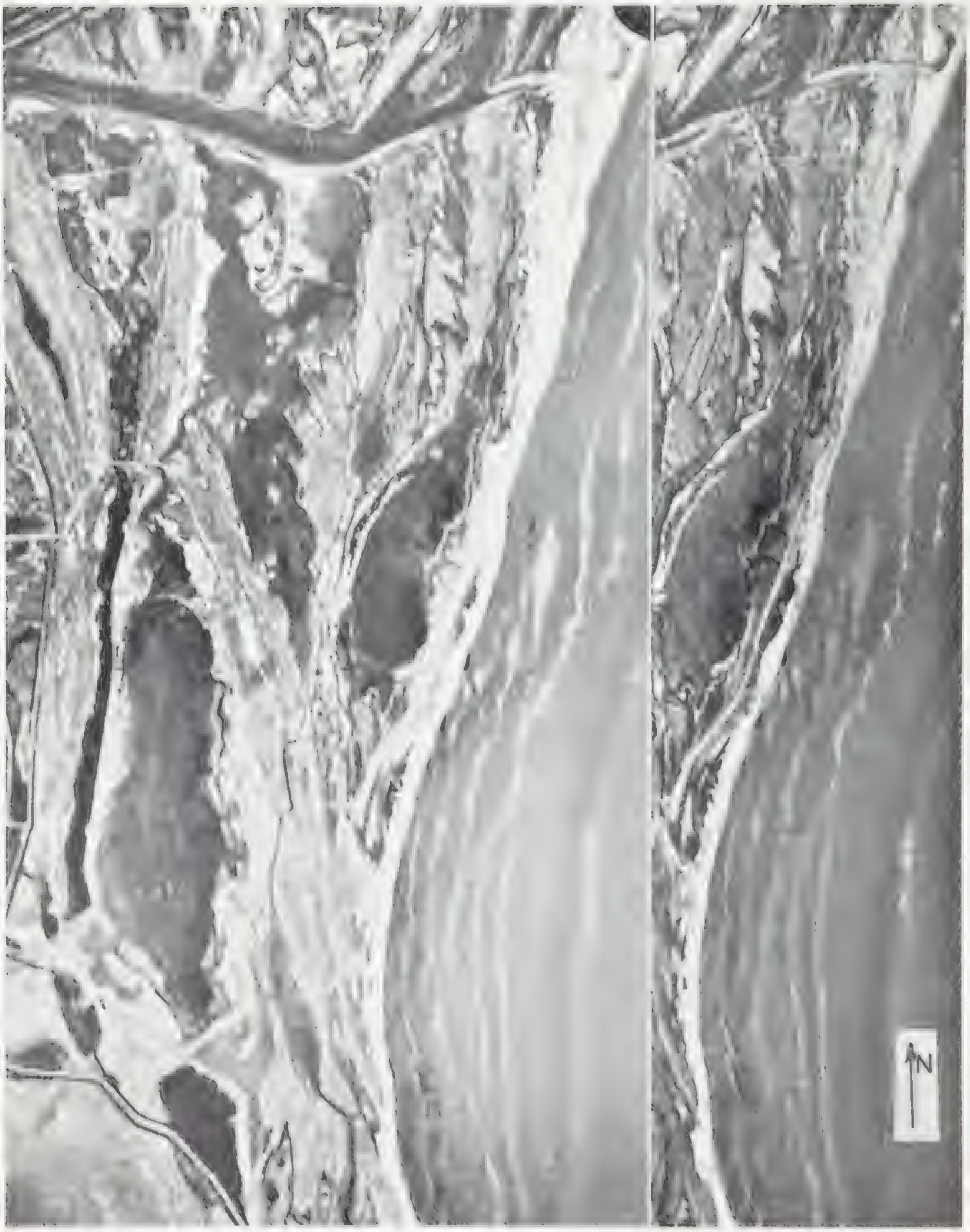
FIG. 1: Multiple and complex bars developed on a sand shoal near Rye on the southern coast of Port Phillip Bay. At its outer edge the shoal is 8 to 12 feet deep, but drops sharply to 24 feet in top left corner.

(1" = 10 Chns. Photo by courtesy Lands Dept. Vic. 29/7/60.)

FIG 2: Off-shore sand barriers developed in shallow water off the low energy western coast of Port Phillip Bay between Kirk's Point and Point Wilson. Emerged shell beds above the level of present high water extend inland on Newer Basalt to near top left corner.

(1" = 13·3 Chns. Photo by courtesy Lands Dept. Vic. 25/2/63.)

PLATE IX



Vertical view with partial stereo-cover of coastal sand ridges on the west coast of Port Phillip Bay between Point Cook and the outlet of Skeleton Creek. Ridges with lobate landward extensions overlie the Newer Basaltic plain, a small part of which is exposed in the bottom left corner.

Small irregular bars are developed off-shore while south to north sand movement has displaced the mouth of Skeleton Creek to the north.

(1" = 13·3 Chns. Photos by courtesy Lands Dept. Vic. 8/3/64.)

PLATE X.

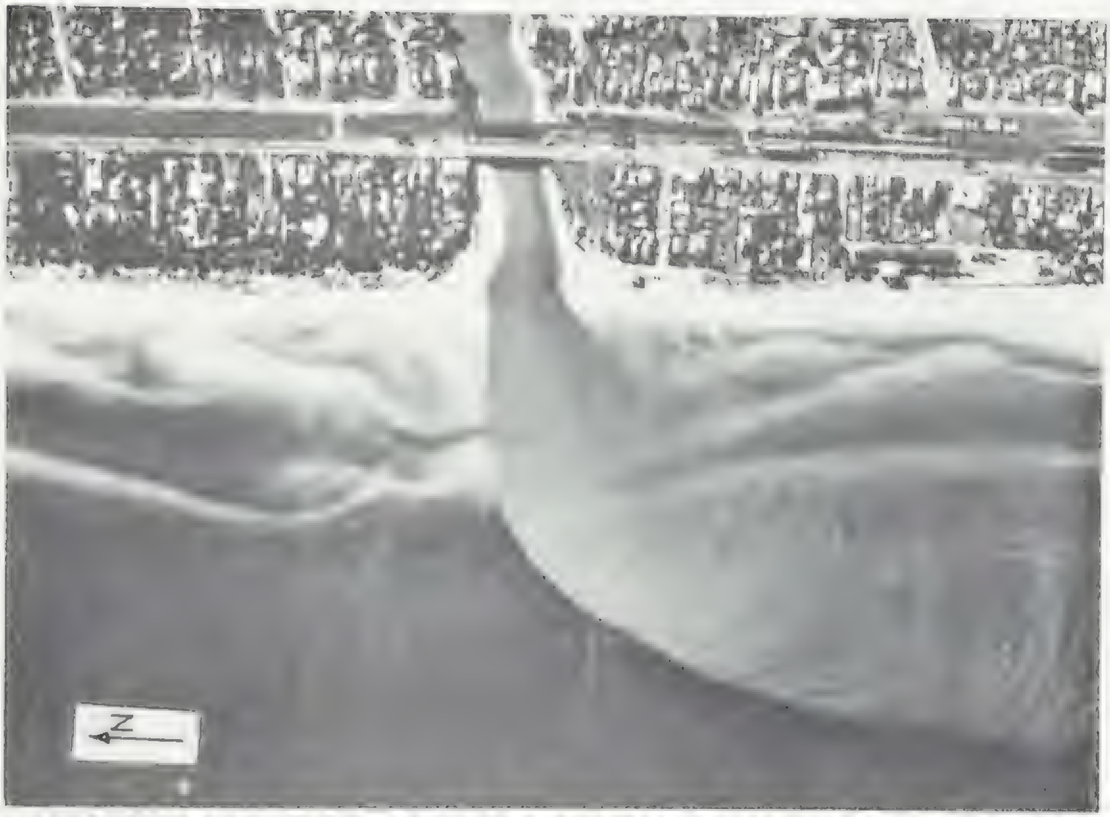


FIG. 1: Coastline near the mouth of the Patterson River, Carrum, on the eastern coast of Port Phillip Bay showing the winter pattern of off-shore bars and the broad sandy beach. Bars oblique to the shore on the right are adjusted to waves from the north and north-west and show evidence of migration from north to south. Waves in the photograph are generated by the influence of north westerly winds. Note the southern diversion of turbid river water on top of sea water.

(1″ 10 Chns. Photo by courtesy Lands Dept. Vic. 13/7/60.)

FIG. 2: Oblique view of the same locality in summer, 1965. The outlet channel of the Patterson River is diverted north by the northerly migration of sand bars developed obliquely to the beach and adjusted to waves from the south-west. Waves in photograph were generated by 20 knots winds from the south-west and, in places, break on all three bars before reaching the beach.

PORT PHILLIP SURVEY 1957–1963.

BOTTOM SEDIMENTS.

By A. W. BEASLEY,

Curator of Minerals, National Museum of Victoria.

SUMMARY.

A survey of the bottom sediments of Port Phillip Bay was undertaken primarily to provide basic data for use in studying the relationships between sediment composition and the occurrence of marine animals and plants. Particle size composition is the principal sediment character studied. Three textural classifications (grade, predominant fraction and textural class) are given for each sample, and a map showing the geographic distribution of the various textural classes is presented.

The bottom sediments of Port Phillip Bay are chiefly sands, silty sands, silty clays and clays. The floor of the extensive area enclosed within the 10-fathom line in the central part of the Bay consists mainly of silty clay in its northern half and of clay in its southern half. Off the eastern shore of the Bay, out to the 6-fathom line, the bottom is mainly sand; and the floor of the Nepean Bay Bar is almost entirely sand. Westwards of the 10-fathom line to the north-west shore of the Bay, sediments of finer grain size are more widespread than off the eastern shore out to the 10-fathom line. The bottom sediments of Geelong Outer Harbour and Inner Harbour (Corio Bay) are chiefly silty clay and clay.

Marine skeletal material constitutes a large portion of the sediments in some localities, high prevalence being associated usually with the coarser-grained sediments and relatively shallow water. The mineral and rock contents of the samples are discussed. In all except one sand sample, the predominant detrital mineral is quartz. Rock fragments are present in many sand and silty sand samples obtained near the shore, as well as in some samples collected several miles from the shore. The bottom sediments are considered to have been derived in part from the reworking of detritus originally deposited by rivers before the Bay was flooded by the sea about 6,000 or 7,000 years ago, and in part from detritus derived since that time from the rivers discharging into the Bay and from coastal and bottom erosion.

INTRODUCTION.

Port Phillip Bay is an almost completely land-locked body of water, with its only opening to the sea at Port Phillip Heads which are 1 $^{9}/_{10}$ miles apart. It is about 31 miles long from north to south, and 20 miles wide at the middle, where on the west side an arm (Western Arm) extends W.S.W. for 15½ miles to Geelong. Port Phillip has a tidal area of 725 square miles, and its water depths range generally from 5 to 13 fathoms, apart from a large area of shoal water in the southern part of the Bay. The latter area constitutes the submerged land surface known as the Nepean Bay Bar (Keble, 1946), which occupies the region south of a line from Rosebud on the Nepean Peninsula to St. Leonards on the Bellarine Peninsula (see Figure 2). Through the shoals a number of channels and tideways run to The Heads. That part of Port Phillip north of the Nepean Bay Bar has been named the Inner Basin (Keble, 1946). Within it there is a large area where water depths range between 10 and 13 fathoms; and, in the central part of the Bay, an extensive area has an approximately level floor at 78 feet.

Since the physical composition of Port Phillip bottom sediments was known to vary from place to place and the geographic distribution of some bottom-dwelling animals and marine plants was thought to be closely associated with sediment type, a survey of the bottom sediments of Port Phillip was undertaken to provide more detailed information on the nature and distribution of the various sediment types. The work was carried out in association with an ecological survey of the Bay conducted as a joint project by the Victorian Fisheries and Wildlife Department and the National Museum of Victoria.

A specific objective of the survey was to ascertain the particle size composition of the sediments and to prepare a map showing the geographic distribution of the various textural classes that could be used by workers conducting the biological investigations.

PREVIOUS KNOWLEDGE.

Although no systematic examination of Port Phillip bottom sediments has previously been carried out, some information concerning the nature of the Bay floor has been available, and erosion and sedimentation along the Bay shores has been studied.

Port Phillip was surveyed by Commander H. L. Cox in 1861, and his chart published in 1864 gives information concerning the nature of the floor of that time. The chart with corrections and additions now forms Admiralty Chart 1171 "Port Phillip". Since 1861, various portions of the floor of Port Phillip have been dumping grounds for material (mostly silty) from dredges and barges.

Admiralty Chart 1171 contains information concerning the present Bay floor, the legend for the various bottom symbols and abbreviations being given on Chart 5011. The bottom sediment symbols on the area enclosed within the 10-fathom line, in the central part of the Bay, all indicate mud or mud and shell except for three symbols indicating shelly sand; these lie close to the southern and western margins of the area enclosed within the 10-fathom line. Offshore from the eastern coastline of the Bay the symbols indicate sand extending seaward usually to depths of 7 or 8 fathoms. Where the floor of the Bay shelves down gently from the eastern and southern shores, sand is marked as extending seaward for distances up to $3\frac{1}{2}$ miles; however, where the bathymetrical contours are closely spaced near the shore (e.g., off Mount Martha, Mornington, Mount Eliza, Rickett's Point and other steeply cliffed sections), mud is marked as close as $\frac{1}{2}$ mile to the coast. The symbols indicating fine sand off the eastern and southern shores occur at places ranging from depths of $4\frac{3}{4}$ fathoms to 8 fathoms; and a coarse sand is marked at $3\frac{1}{2}$ fathoms off Green Point, Brighton Beach. Offshore from the western coastline of the Bay mud is indicated usually in depths of more than 6 fathoms, but it is also marked in much shallower water, such as at $1\frac{3}{4}$ fathoms north of Point Cook. Almost all the soundings in Geelong Outer Harbour and Corio Bay bottom on mud, and at two places clay is marked.

Admiralty Chart 1171 has symbols indicating "stones" and "rock" at various places adjacent to and at some little distance from the shore. Usually these are offshore from high, rocky cliffs such as occur at Picnic

Point (Sandringham), Oliver's Hill (Frankston), Davy Point, Fisherman's Bay (Mornington), Balcombe Bay, Observatory Point, Point Nepean, Point Lonsdale, Indented Head and Point George; but, along the north-western shore, they are found off places such as Point Wilson, Kirk Point, Beacon Point and Point Cook where there are only low cliffs. The places marked as "reefs" on the Chart are apparently all submarine rock outcrops, as are those where the markings indicate "rock". However, the markings indicating "stones" may refer to detached rocks and minerals that have been transported.

Some data concerning the floor of Port Phillip is contained in Volume II. of the "Australia Pilot" (1956). This publication describes the natural boundary of shallow banks and a submarine rock ledge between Point Lillias and Point Henry, which separate Geelong Outer Harbour from Corio Bay. Various reefs and rocky patches, such as those off Picnic Point (Sandringham), are described in detail. Off the north-western shore of Port Phillip, from a projection about 4 miles north-east of the Werribee River mouth, a shallow, rocky spit is recorded as extending seawards about $\frac{1}{2}$ mile; and from Point Cook another shallow, rocky spit is said to extend for approximately 1 mile eastward. A reef is recorded as extending seawards to about $\frac{1}{5}$ mile east-south-east of Altona jetty; and, on a shallow bank which fronts the shore between Altona jetty and the mouth of Kororoit Creek, two rocky patches are described, the outer one lying $\frac{3}{4}$ mile offshore. According to the "Australia Pilot", the shore between the mouth of Kororoit Creek and Point Gellibrand is bordered by rocky ground which extends as far as $^{4}/_{10}$ mile offshore; and Point Gellibrand itself is bordered by rocky ground which extends about $^{3}/_{10}$ mile southward and $\frac{1}{2}$ mile east-south-eastward. Some additional information concerning the location of submarine reefs, shoals, &c., on the floor of Port Phillip is contained in "Sailing Directions, Victoria, including Bass Strait" (1959).

Following an investigation of the shores of Port Phillip Bay to ascertain where erosion and sedimentation were taking place, and in the recent past had taken place, Jutson (1931, p. 132) stated that "broadly speaking, and with certain exceptions, erosion appears to be taking place on the eastern side of the Bay, and sedimentation on the western side." He believed that the primary causes of erosion on the eastern side are the power of the waves formed by strong southerly and south-westerly winds, and the weak character of the rocks in many places—e.g., the sediments forming the cliffs between Brighton and Mordialloc are mainly poorly consolidated Tertiary and unconsolidated Quaternary sands which are easily removed. On the western shore of Port Phillip from the Yarra mouth to the north-western corner of Corio Bay, sedimentation is indicated by the occurrence of extensive Holocene marine deposits which Jutson (1931, p. 151) believed, in some instances at least, have undoubtedly been formed at present sea-level. Jutson considered that the sedimentation on the western side of the Bay might be due to the slowing down of a current bringing detritus from the Bay's eastern side, as well as to the large quantity of sediment brought into the Bay by the Yarra and Maribyrnong Rivers, and also that brought in by the Werribee and Little Rivers, and some smaller streams. Jutson's observations made around Corio Bay and Geelong Outer Harbour indicated that both sedimentation and erosion are taking place there.

Little investigation has been carried out on water currents in Port Phillip, but tidal currents are known to be strong in the southern part of the Bay. According to the "Australia Pilot" (1956, p. 76), the tidal streams in the Entrance to Port Phillip have velocities of from 5 to 8 knots at about the time of high and low water. The rate of the tidal stream is affected by the wind; a southerly wind is the prevalent wind at Port Phillip Heads, but northerlies are scarcely less prevalent. The "Australia Pilot" (1956, p. 76) records that "through the South Channel the in-going tidal stream sets at a rate of from 1 knot to $1\frac{1}{4}$ knots, whereas the out-going stream sets through at a rate of from $\frac{3}{4}$ knot to 2 knots". Keble (1946, p. 88) has stated that "the velocity of the tidal streams is practically the same from top to bottom". The tidal streams in Geelong Outer Harbour and Corio Bay are at all times feeble and irregular except where Hopetoun Channel crosses the bank between Point Henry and Point Lillias; the out-going stream there has a rate of up to 1 knot. The "Australia Pilot" (1956, p. 104) records that in Hobson's Bay the tidal streams are weak and their direction is mostly dominated by the prevailing winds. The waters of the River Yarra are almost continually running outward. Even during the in-going tidal stream the water, from the surface to a depth of about 12 feet, is running out. Under the influence of strong southerly to westerly winds, however, an upstream current is caused. The normal rate of outflow is from $\frac{1}{4}$ to $\frac{1}{2}$ knot, but this is accelerated during heavy rains when its rate may attain 4 knots.

Random observations made by boating men and skin-divers have revealed marked movements of bottom sediments in some of the shallower but fairly exposed sandy parts of the Bay; sand banks are reported to be in different positions at different times. Variations are said to be greatest after periods of rough seas with gale-force winds. Skin-divers have reported the presence of much clay and silty material suspended in the water, particularly in the north-western and northern parts of the Bay, after heavy rain and flooding of watersheds; they have observed that commonly the turbidity of the sea-water gradually extends in a south-easterly direction towards the Mornington area within several days.

Considerable movement of sand in the Nepean Bay Bar area of Port Phillip is evidenced by the fact that dredging is required to maintain the shipping channels at fixed depths.

As indicated above, submarine rock outcrops occur at various places in Port Phillip. Usually these are fairly near the shore, but some in the north-western part of the Bay occur at quite considerable distances from the shoreline. Submarine outcrops of dune-limestone occur near The Heads and extend across the Entrance to Port Phillip.

GEOLOGICAL AND PHYSIOGRAPHIC SETTING

Port Phillip Bay is part of a larger area called the Port Phillip Sunkland, formed by the down-faulting in Cainozoic times of the region between the Rowsley Fault in the west and Selwyn's Fault in the east. Selwyn's Fault, which runs approximately parallel to the western side of the Mornington Peninsula between Frankston and Dromana, has been active since early Tertiary times, according to Hills (1960, p. 160). It is a hinge fault, the displacement dying out to the north but increasing towards the south. Gill (1964a, p. 345) has stated that the Rowsley

Fault, which runs from the Anakies north of Geelong, past Bacchus Marsh, and north towards Mount Macedon, is later than Lower Pliocene and probably Upper Pliocene in age. Subsequent flooding of part of this depressed, mainly low-lying area by the sea, due to the eustatic rise of sea-level beginning in late Pleistocene and extending to mid-Holocene times, has given rise to Port Phillip Bay. It is believed that most of Port Phillip Bay was a land surface as recently as 7,000 years ago. The topography of the land before it was submerged has largely controlled the configuration and depth of the Bay. According to Hills (1960, p. 163), Corio Bay is probably due to the drowning of a fault angle depression, bounded on the south by a fault along the northern edge of the Bellarine Peninsula.

Keble (1946), in a paper concerning the Port Phillip and Bass Strait Sunklands, stated that in Pleistocene times the land surface was drained by a river system of which the Yarra River was part. The early Yarra flowed southwards over what is now the floor of Port Phillip Bay and joined a trunk-stream, the Tamar Major River, which entered the Southern Ocean between Cape Otway and King Island. Keble (1946, p. 73) has reconstructed the valley of the Yarra during late Pleistocene and early Holocene times by connecting up soundings on Admiralty Chart 1171 into bathymetrical contour-lines. After this was done, the sunken river system showed up distinctly, and the Werribee River, Little River, Kororoit Creek, and other streams now discharging into Port Phillip are seen to have been former tributaries of the early Yarra. The eustatic rise of sea-level drowned the lower part of the river system. During eustatic low sea-levels in the Pleistocene Period, the early Yarra apparently carved out a broad valley and, in its lower reaches, flowed on a mature land surface. In Upper Pleistocene times, dune building established a bar across the "mouth" of Port Phillip; the formation and geomorphology of this Nepean Bay Bar have been described by Keble (1946, pp. 82-90). Keble interpreted the extensive area with an approximately level floor at 78 feet, north of the Nepean Bay Bar, as the delta of the Yarra River in late Pleistocene and early Holocene times. The crowding of the bathymetrical contours on the eastern side of the Bay is thought to be due to the faulting (Selwyn's Fault) plus the scouring developed thereby.

In Upper Holocene times the sea-level in Port Phillip fell some 10 or 12 feet, presumably from glacio-eustatic causes. Evidence of this emergence (raised beaches, submarine banks and shore platforms) is preserved at Hampton, Altona and other places around Port Phillip, and has been described by Hart (1893), Jutson (1931), Hills (1940), Gill (1950a; 1961; 1964b) and others.

The shoreline of Port Phillip is mostly low-lying, the main exceptions being parts of the Mornington and Bellarine Peninsulas. Keble (1946, p. 72) stated that "long stretches of the eastern shores are low and shelving—they consist mainly of littoral, alluvial or delta deposits, which have, at places, been piled up as dunes, or scoured out as submarine ridges uncovered, it is thought, by the eustatic fall of sea-level". The eastern shore is cliffed between the various low stretches of coast. Between the north end of Port Phillip and Mordialloc the coastline is known to have receded through foreshore erosion, as it has also from Frankston to Dromana and along the north-eastern part of the Bellarine Peninsula.

The western shore of the Port Phillip Inner Basin is mainly flat and prograded, and, according to Keble (1946, p. 74), is due to the gentle tilting on a warp inshore of the almost level surface of the Werribee Plains and Keilor Plains lava-fields. The gradually sloping, south-easterly dipping basalt plain shelves beneath the waters of Port Phillip along its north-western shore.

The Bay shore of the Nepean Peninsula consists of beaches, broken by cliffs of dune-limestone. This contrasts with the shore of the Bellarine Peninsula which at Point Lonsdale and Queenscliff is cliffy, but further north is low-lying. At The Bluff (South Red Bluff), St. Leonards and other places still further north, there are low cliffs of Tertiary sandstones.

Some indications of the rocks underlying Port Phillip were obtained by a gravity survey of the Bay carried out by the Commonwealth Government. In the report of this work, Gunson, Williams and Dooley (1959, p. 2) stated that " high gravity features in the western part of Port Phillip between Altona and Portarlington may be associated with masses of basalt ". The geophysical work suggests that basalt extends beneath the waters of Port Phillip in places up to 6 miles south-eastward from the present north-western shore.

Seven bores (Parl. Pap. 1864-5) put down on various sand-banks of the Nepean Bay Bar all encountered dune-limestone beneath sand ranging from 8½ to 23½ feet in thickness; and Keble (1946) considered that Pleistocene dune-limestone underlies the entire submerged land surface of the Nepean Bay Bar.

The only islands in Port Phillip are situated within the area of the Nepean Bay Bar, and they are low and sandy. The group known as Mud Islands contain small outcrops of Pleistocene dune-limestone, but Swan Island and nearby Duck Island, north of Queenscliff, have no rock outcrops. The latter islands are composed of sand ridges and silty material. In the sand ridges of Swan Island, Jutson (1931, p. 142) recorded that water-worn pebbles of ironstone, quartz, basalt and sandstone occur up to 3 or 4 inches in diameter.

The main streams discharging into Port Phillip are the Yarra River (the largest tributary of which is the Maribyrnong River), the Werribee River and the Little River. The Yarra River flows mainly over Silurian sedimentary rocks, many of which have an appreciable content of clay and silt-size particles. The Maribyrnong joins the Yarra River close to its mouth, and for many miles its valley is cut through Newer Volcanic basalt into the underlying rocks (Cainozoic sediments and Silurian rocks). Particularly following prolonged rainfall in the Yarra watershed, large quantities of silt and clay are transported in suspension by this river and discharged into the Bay.

The Werribee and Little Rivers are less important streams with shallow mouths. However, during periods of flooding their size increases considerably and they transport an appreciable amount of detrital material which is deposited in the Bay. Three much smaller creeks flow into Corio Bay.

On the eastern side of Port Phillip a few small creeks drain the swamplands of Carrum Downs and the Mornington Peninsula, but their effect in discharging detrital material is very small.

With reference to the geology of the land areas fringing the Bay, only a brief account is necessary here. The majority of the area surrounding the Bay is covered by Quaternary and Tertiary sediments and by Cainozoic basalts. Granitic rocks outcrop along the shore at Frankston, as well as at about 1 mile N.E. of the mouth of Tanti Creek (Mornington), at Mount Martha and Dromana, and they occur at Mount Eliza, Arthur's Seat, in the You Yangs and north-east from Dandenong.

The rocks of the shore platforms and cliffs along the north-eastern coastline between Brighton and Mordialloc belong to a Tertiary fluviatile-marine formation called the Sandringham Sands (Gill, 1950b); they are overlain by Holocene, wind-blown sands. The Tertiary sediments consist of ferruginous sands, sandstones and gravelstones of varying degrees of cementation and consolidation. The sands and sandstones are commonly very soft, and have quite a high clay content. Carroll (1949) found that the clay content of the Tertiary sandstones at Beaumaris averaged 19 per cent. The lowest Tertiary horizon exposed is commonly constituted of resistant ironstone. The overlying Holocene sands are generally fine-grained and have a much lower clay content than the Tertiary sediments. Most probably they were derived from pre-existing beaches from which the sand was born inland by prevailing onshore winds during the mid-Holocene arid period (Whincup, 1944). Recent dune sands occur along the coast from Mordialloc to Frankston.

Between Frankston and Mount Martha, Tertiary ferruginous sandstones (the Baxter Sandstones) occur, as well as some Tertiary shelly marls, clays and somewhat decomposed Older Volcanic basalt. Most of these rocks are easily removed by marine erosion.

On the Nepean Peninsula, Pleistocene dune-limestone outcrops extensively (Keble, 1950), and this rock also covers an area west of The Heads at Point Lonsdale and Queenscliff. Along the shores, the dune-limestone, on account of numerous contained patches of loose sand and unindurated material, is being rapidly eroded, resulting in wave-cut platforms and steep cliffs.

On the western side of the Bay, from the Yarra mouth to the north-western corner of Corio Bay, the rocks are chiefly Newer Volcanic basalt which is hard and resists erosion. The basalt occurs along the shore in the Williamstown area, at Beacon Point, Kirk Point, near Point Wilson and at Point Lillias. Elsewhere in this section of the coast, Quaternary marine deposits, composed mainly of quartzose and shelly sand with pebbles of quartz, sandstone and basalt, and alluvium occur along the shore.

At the western end of Corio Bay, cliffs of calcareous sand, sandy clay, and other sediments of Tertiary age occur along the coast. Point Henry is composed of soft clays of Upper Pliocene or Lower Pleistocene age. Along the north shore of the Bellarine Peninsula there are outcrops of Tertiary limestone, ferruginous sandstone and Older Volcanic basalt. Tertiary sedimentary rocks (mainly ferruginous sandstone) also occur on the eastern shore of the Bellarine Peninsula as far south as The Bluff.

MATERIALS AND METHODS.

Most of the samples studied were secured by skin-divers descending to the Bay floor and pressing the top two inches of bottom sediments into a glass jar. Other samples were obtained by drag-dredging from the Fisheries and Wildlife Department's vessel "Caprella", in places where it was considered that satisfactory samples might be secured, viz., in relatively deep water where the bottom sediments were known to be stiff and sticky with a high clay content. By the dredge skimming the surface of the deposit, the top inch or so of bottom sediments along a line was collected in the dredge bag. Specimens from submarine rock outcrops and detached boulders, as well as pebbles, were collected by skin-divers wherever possible. Visual information concerning the nature of the Bay floor (e.g., ripple-marking on its surface), estimated current strength and actual movement of sediments, has been obtained from skin-diving (see Table 2).

The fixing of stations was facilitated by the division of Admiralty Chart 1171 into areas by means of a grid of 4′ of latitude by 4′ longitude using 38°S and 145°E as base references. Commencing at the north-west corner of the chart the squares of the grid were numbered in running sequence from 1 to 70. The precise location of stations from where samples were collected was determined through intersections from compass bearings on prominent landmarks, beacons, etc., the resulting position being marked on the chart.

The location of these stations is shown on Chart 2 (back of the volume), and a list of station numbers together with relevant information is given in Table A (back of volume). Samples of bottom sediments were not collected for this study from every station. An "Inshore Ferrograph" calibrated in feet was used to determine the water depth at most stations. Where it was not used, the water depth shown in the Table is that obtained from the Admiralty Charts or the depth-meters attached to skin-divers.

Fewer sediment samples were collected from areas within the 10-fathom line in the central part of the Bay, as this is largely uniform in its physical composition. Most samples were collected in depths of less than 10 fathoms where the sediments and marine life are more varied in their nature.

In brief, the laboratory procedure was as follows: The sample was dried and, where necessary, thoroughly mixed and reduced in bulk by coning and quartering to about 100 grams. Where noticeable, weed material was removed by hand picking with tweezers, and its relative abundance noted. Complete shells containing soft parts were also removed by hand. The sample was then weighed and any clay present was removed by subsidation techniques. Where necessary, a solution of sodium hexametaphosphate was added to assist the dispersion of the clay. After complete removal of the clay, the residue was dried, weighed and the percentage of clay (plus soluble salts and sometimes a little weed material) in the bottom sample was calculated. With the clay fraction removed, the material was then shaken in a nest of sieves with a mechanical shaker for 20 minutes. British Standard Series sieves were used to divide the material into the Wentworth classes listed in Table 1, except clay.

TABLE 1.—WENTWORTH CLASSES AND TEXTURAL GRADES WITH CORRESPONDING SIZE RANGES OF EACH IN MILLIMETRES.

Wentworth Classes.	Grade.	Size. (mm.)
Granule	Gravel	Above 2
Very coarse sand	Sand	2 to 1
Coarse sand		1 to $\frac{1}{2}$
Medium sand		$\frac{1}{2}$ to $\frac{1}{4}$
Fine sand		$\frac{1}{4}$ to $\frac{1}{8}$
Very find sand		$\frac{1}{8}$ to $^{1}/_{16}$
Silt	Silt	$^{1}/_{16}$ to $^{1}/_{256}$
Clay	Clay	Below $^{1}/_{256}$

Following weighing, the percentages of silt, sand and gravel (where present) in the bottom sample were calculated. This quantitative data, together with the clay percentage, is recorded in Table 2. The various size fractions were examined with a hand lens or under the microscope, and significant findings concerning mineral composition, degree of grain roundness, &c., were recorded (see Table 2). The relative abundance of marine skeletal material (shell fragments, &c.) was estimated by eye in the whole sample and in certain of the size fractions, and recorded in Table 2 as A — Very abundant; a — Abundant; C — Very common; c — common; s — Scarce; S — Very scarce. Rock pebbles and specimens from submarine outcrops and detached boulders were broken (to examine fresh surfaces) and identified, when necessary, by chemical, physical and optical means.

In regard to the geographic distribution of sediment types, in presenting the data in Figure 1 it was frequently necessary to extrapolate a considerable distance. Previously published information, such as that marked by symbols and abbreviations on the Admiralty Charts, has been used as a guide in extrapolating sediment distribution.

RESULTS.

General.

The results of this study contain a considerable amount of new information obtained by refinements in the methods of studying the floor sediments of Port Phillip Bay. The bottom sediments of Port Phillip Bay are chiefly sands, silty sands, silty clays and clays. The floor of the extensive area enclosed within the 10-fathom line in the central part of the Bay consists mainly of silty clay in its northern half and of clay in its southern half. Off the eastern shore of the Bay, out to at least the 6-fathom line, the bottom is generally sand; and the floor of the Nepean Bay Bar, the region south of a line from Rosebud to St. Leonards, is almost entirely sand. Westwards of the 10-fathom line to the north-west shore of the Bay, sediments of finer grain size are more widespread than off the eastern shore out to the 10-fathom line. The bottom sediments of Geelong Outer Harbour and Inner Harbour (Corio Bay) are chiefly silty clay and clay; in the Outer Harbour, sand and silty sand commonly occur from the shore out to depths of 3 or 4 fathoms.

Table 2 contains the main body of data resulting from this study.

TABLE 2.—PRINCIPAL DESCRIPTIVE FEATURES OF EACH SEDIMENT SAMPLE EXAMINED, WEIGHT PERCENTAGES OF GRADES, AND ADDITIONAL INFORMATION.

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
10	Sand ..	Coarse sand	Sand ..	Quartz ..	a	1·9	97·4	0·4	0·3	Ferruginous sandstone fragments present. Diver reported irregular rocky floor.
11	Sand ..	Very fine sand	Sand ..	Quartz ..	s	..	78·4	9·0	12·6	Basalt fragments present.
12	Sand ..	Very fine sand	Sand ..	Quartz ..	s	..	79·1	9·0	11·9	
14	Sand ..	Fine sand	Sand ..	Quartz ..	s	..	93·8	2·9	3·3	Basalt fragments present
15	Sand ..	Fine sand	Sand ..	Quartz ..	c	..	97·9	1·5	0·6	
16	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·3	98·0	0·1	1·6	Granite fragments and biotite flakes common.
17	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·4	98·0	0·1	1·5	As for No. 16
18	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·2	97·8	0·1	1·9	As for No. 16.
19	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·2	98·1	0·1	1·6	As for No. 16.
20	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·2	98·0	0·1	1·7	As for No. 16.
21	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·2	98·4	0·1	1·3	As for No. 16.
22	Sand ..	Medium sand	Sand ..	Quartz ..	c	1·2	98·5	0·1	0·2	Ironstone particles conspicuous.
30	Sand ..	Medium sand	Sand ..	Quartz ..	c	0·5	98·3	0·1	1·1	Ironstone particles and biotite flakes conspicuous.
32	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·5	98·1	0·3	1·1	Well sorted sand with biotite flakes and ironstone particles conspicuous.
36	Sand ..	Fine sand	Sand ..	Quartz ..	A	..	98·3	1·2	0·5	Basalt fragments present.
40	Clay ..	Clay ..	Sand-silt-clay	Clay ..	s	..	20·9	30·0	49·1	Biotite flakes present. Diver reported presence of rock.
41	Sand ..	Very coarse sand	Sand ..	Clay ..	A	1·5	79·5	4·0	15·0	A shell sand. Quartz grains scarce. Weathered basalt fragments present.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content (%)	Silt content (%)	Clay content (%)*	General Remarks.
42	Sand ..	Clay ..	Clayey sand	Quartz..	c	..	58·6	11·0	30·4	
43	Sand ..	Coarse sand	Sand ..	Quartz..	c	0·4	97·0	1·7	0·9	Ironstone particles present.
44	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	55·9	24·7	19·4	
45	Sand ..	Very fine sand	Silty sand	Quartz..	s	0·8	45·9	35·1	18·2	Fragments of calcareous quartz sandstone present.
46	Clay ..	Clay ..	Silty clay	Quartz..	S	.	22·1	30·0	47·9	Diver reported fairly strong current. Mica flakes conspicuous.
48	Clay ..	Clay ..	Silty clay	Clay ..	S	..	5·6	38·6	55·8	
49	Clay ..	Clay ..	Silty clay	Clay ..	s	..	10·8	28·9	60·3	
51	Sand ..	Fine sand	Sand ..	Quartz..	c	0·2	86·5	4·6	8·7	Fragments of ferruginous sandstone and ironstone present.
53	Sand ..	Coarse sand	Sand ..	Quartz..	A	0·5	93·1	3·0	3·4	Shelly sand containing particles of weathered basalt and ironstone.
55	Sand ..	Coarse sand	Sand ..	Quartz..	a	0·2	88·1	7·4	4·3	Poorly sorted sand containing particles of weathered basalt and ironstone. Diver reported submarine rock outcrop.
56	Sand ..	Coarse sand	Sand ..	Quartz..	A	19·2	75·1	1·5	4·2	Poorly sorted, shelly sand containing basalt pebbles up to $1\frac{1}{2}''$ in diameter.
58	Sand ..	Coarse sand	Sand ..	Quartz..	a	0·4	82·0	9·4	8·2	Poorly sorted, shelly sand containing fragments of weathered basalt and ferruginous sandstone.
59	Sand ..	Fine sand	Sand ..	Quartz..	S	..	85·7	5·0	9·3	

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content (%).	Sand content (%).	Silt content (%).	Clay content (%).*	General Remarks.
60	Sand ..	Fine sand	Sand ..	Quartz..	s	..	95·1	2·4	2·5	Diver reported presence of rock.
61	Sand ..	Medium sand	Sand ..	Quartz..	c	..	97·2	1·3	1·5	
62	Sand ..	Medium sand	Sand ..	Quartz..	c	..	93·7	1·8	4·5	Poorly sorted sand. Quartz grains commonly subangular.
63	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	61·6	19·9	18·5	Ironstone particles conspicuous.
65	Sand ..	Coarse sand	Sand ..	Quartz..	A	..	85·2	4·4	10·4	Diver reported submarine rock outcrop (?basalt)
66	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	57·7	28·8	13·5	Quartz grains commonly subangular.
67	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	69·0	23·8	7·2	Ironstone particles conspicuous.
68	Sand ..	Fine sand	Clayey sand	Quartz..	s	..	48·9	11·6	39·5	
69	Clay ..	Clay ..	Silty clay	Clay ..	S	..	7·0	35·3	57·7	
70	Clay ..	Clay ..	Silty clay	Clay ..	S	..	6·1	30·5	63·4	
71	Clay ..	Clay ..	Silty clay	Clay ..	S	..	2·9	25·1	72·0	Sediment dark grey in colour.
72	Clay ..	Clay ..	Silty clay	Clay ..	S	..	3·1	26·0	70·9	
74	Sand ..	Very fine sand	Sand ..	Quartz..	s	..	75·8	10·3	13·9	
75	Sand ..	Very fine sand	Sand ..	Quartz..	s	..	84·8	7·1	8·1	
76	Sand ..	Coarse sand	Sand ..	Quartz..	c	0·2	98·7	0·1	1·0	
79	Sand ..	Fine sand	Sand ..	Quartz..	c	..	98·2	1·2	0·6	Diver reported very strong current.
82	Sand ..	Coarse sand	Sand ..	Quartz..	c	1·1	80·4	2·5	16·0	Poorly sorted sand. Diver reported submarine rock [illegible]
83	Sand ..	Coarse sand	Sand ..	Quartz..	s	..	96·8	1·4	1·8	
92	Sand ..	Coarse sand	Sand ..	Quartz..	s	0·4	96·9	1·1	1·6	Diver reported ripple-marked floor.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
93	Sand ..	Medium sand	Sand ..	Quartz..	c	0·2	97·3	1·2	1·3	Diver reported submarine rock outcrop.
95	Sand ..	Medium sand	Sand ..	Quartz..	c	0·2	97·9	1·2	0·7	Diver reported submarine rock outcrop.
96	Sand ..	Medium sand	Sand ..	Quartz..	c	..	98·7	0·1	1·2	
97	Sand ..	Fine sand	Sand ..	Quartz..	c	1·4	97·1	0·2	1·3	
99	Sand ..	Coarse sand	Sand ..	Quartz..	C	1·2	94·3	1·9	2·6	
100	Sand ..	Coarse sand	Sand ..	Quartz..	c	0·9	97·8	0·1	1·2	
101	Sand ..	Fine sand	Sand ..	Quartz..	c	..	98·6	1·9	1·3	
103	Silt ..	Silt ..	Clayey silt	Clay ..	s	..	12·6	72·8	14·6	
107	Sand ..	Fine sand	Sand ..	Quartz..	s	1·9	96·7	1·1	0·3	Poorly sorted sand containing basalt fragments.
108	Clay ..	Clay ..	Sand-silt-clay	Quartz..	S	..	29·7	33·9	36·4	
110	Clay ..	Clay ..	Sand-silt-clay	Quartz..	s	..	23·0	33·1	43·9	
111	Clay ..	Clay ..	Sand-silt-clay	Clay ..	s	..	22·7	26·5	50·8	
112	Clay ..	Clay ..	Silty clay	Clay ..	S	..	16·7	34·2	49·1	
114	Clay ..	Clay ..	Silty clay	Clay ..	S	..	18·8	28·4	52·8	
115	Clay ..	Clay ..	Silty clay	Clay ..	S	..	12·3	40·7	47·0	Mica flakes conspicuous.
119	Clay ..	Clay ..	Silty clay	Clay ..	S	..	11·8	35·5	52·7	Mica flakes conspicuous.
122	Sand ..	Coarse sand	Sand ..	Quartz..	c	..	90·7	4·8	4·5	Poorly sorted sand.
123	Sand ..	Coarse sand	Sand ..	Quartz..	c	2·0	96·3	1·4	0·3	Poorly sorted sand containing pebbles of calcareous rock, probably of accretionary origin.
124	Clay ..	Clay ..	Silty clay	Clay ..	S	..	9·8	15·4	74·8	Diver reported much suspended sediment in water.
125	Sand ..	Fine sand	Clayey sand	Quartz..	s	..	71·9	10·5	17·6	Diver reported much suspended sediment in water.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
126	Clay ..	Clay ..	Silty clay	Clay ..	S	..	4·3	36·4	59·3	
127	Clay ..	Clay ..	Silty clay	Clay ..	S	..	14·9	14·7	70·4	
128	Clay ..	Clay ..	Silty clay	Clay ..	S	..	1·2	40·0	58·8	Weathered basalt particles present. Mica flakes conspicuous.
129	Clay ..	Clay ..	Silty clay	Clay ..	S	..	3·3	38·3	58·4	Weathered basalt particles present.
130	Silt ..	Silt ..	Sand-clay-silt	Quartz..	s	..	23·3	48·1	28·6	
131	Silt ..	Silt ..	Clayey silt	Clay ..	s	..	18·3	42·2	39·5	
135	Sand ..	Coarse sand	Sand ..	Quartz..	c	1·1	95·5	1·6	1·8	Fragments of ferruginous sandstone present.
136	Silt ..	Silt ..	Sandy silt	Quartz..	s	..	36·4	49·3	14·3	
137	Sand ..	Very coarse sand	Sand ..	Quartz..	A	8·5	85·4	2·1	4·0	Shelly sand containing weathered basalt fragments. Diver reported submarine rock outcrop.
138	Sand ..	Very coarse sand	Silty sand	Quartz..	A	2·1	68·8	21·4	7·7	Shelly sand containing decomposed basalt and limestone fragments.
139	Sand ..	Coarse sand	Silty sand	Clay ..	A	2·0	74·8	11·9	11·3	Shelly sand; quartz grains scarce. Diver reported submarine rock outcrop rising 2 feet above bottom.
144	Silt ..	Silt ..	Clayey silt	Quartz..	s	..	15·3	68·6	16·1	
145	Silt ..	Silt ..	Clayey silt	Quartz..	s	..	6·9	74·6	18·5	Ironstone particles conspicuous.
146	Silt ..	Silt ..	Sandy silt	Quartz..	s	..	30·6	61·8	7·6	Ironstone particles conspicuous.
147	Sand ..	Coarse sand	Sand ..	Quartz..	s	..	97·3	1·3	1·4	Ironstone particles conspicuous.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2 *continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material	Gravel content (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
148	Sand ..	Coarse sand	Sand ..	Quartz..	a	2·8	91·6	3·0	2·6	Fragments of very ferruginous sandstone and ironstone present. Diver reported very rocky bottom.
150	Sand ..	Very coarse sand	Sand ..	Quartz..	A	4·5	94·4	0·4	0·7	Dune-limestone fragments present. Diver reported submarine outcrop of dune-limestone.
151	Sand ..	Medium sand	Sand ..	Quartz..	A	0·8	96·5	1·8	0·9	Dune-limestone fragments present. Diver reported flat submarine outcrop of dune-limestone with sandy patches.
152	Sand ..	Medium sand	Sand ..	Quartz..	A	..	96·1	2·8	1·1	Dune-limestone fragments present. Diver reported outcrops of dune-limestone.
153	Sand ..	Fine sand	Silty sand	Quartz..	A	..	72·3	27·0	1·7	Diver reported submarine outcrop of dune-limestone.
154	Sand ..	Fine sand	Sand ..	Quartz..	A	..	94·2	4·7	1·1	Diver reported dune-limestone fragments and very fast current.
155	Sand ..	Fine sand	Sand ..	Quartz..	a	..	75·1	15·8	9·1	
156	Sand ..	Fine sand	Sand ..	Quartz..	a	..	79·7	14·4	5·9	
157	Sand ..	Fine sand	Sand ..	Quartz..	a	..	84·2	13·7	2·1	
158	Sand ..	Fine sand	Sand ..	Quartz..	a	..	82·3	14·9	2·8	
159	Silt ..	Silt ..	Clayey silt	Quartz..	S	..	13·3	68·8	17·9	
160	Sand ..	Coarse sand	Sand ..	Quartz..	c	1·1	98·5	0·2	0·2	Hornfels pebbles present.
161	Sand ..	Coarse sand	Sand ..	Quartz..	c	1·4	98·3	0·1	0·2	Hornfels, granite and quartz pebbles present. Biotite flakes common.
162	Sand ..	Medium sand	Sand ..	Quartz..	s	..	99·2	0·6	0·2	As for No. 161.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued*.

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
163	Sand ..	Medium sand	Sand ..	Quartz..	c	..	99·1	0·6	0·3	Diver reported submarine rock outcrop. Biotite flakes common.
165	Sand ..	Fine sand	Silty sand	Quartz..	s	..	63·2	34·9	1·9	Basalt fragments present.
166	Sand ..	Fine sand	Silty sand	Quartz..	s	..	74·9	22·2	2·9	Diver reported rock below sand.
167	Sand ..	Fine sand	Silty sand	Quartz..	s	..	67·3	29·2	3·5	
168	Sand ..	Medium sand	Sand ..	Quartz..	a	0·2	84·4	14·2	1·2	
169	Silt ..	Silt ..	Sandy silt	Quartz..	s	..	28·8	65·5	5·7	
170	Sand ..	Fine sand	Silty sand	Quartz..	s	..	69·9	24·7	5·4	
171	Silt ..	Silt ..	Sandy silt	Quartz..	s	..	28·7	67·2	4·1	Diver reported black "mud" beneath fine sand.
172	Silt ..	Silt ..	Sandy silt	Quartz..	s	1·1	19·2	74·2	5·5	Diver reported submarine rock outcrop.
174	Silt ..	Silt ..	Sandy silt	Quartz..	s	..	38·7	43·8	17·5	
177	Clay ..	Clay ..	Silty clay	Clay ..	S	..	4·6	28·6	66·8	
178	Sand ..	Fine sand	Sand ..	Quartz..	s	0·9	96·0	1·7	1·4	Poorly sorted sand containing basalt fragments. Floor ripple-marked.
179	Sand ..	Medium sand	Sand ..	Quartz..	c	4·6	91·0	3·3	1·1	Poorly sorted sand containing pebbles of milky quartz and fine-grained sandstone. Floor ripple-marked.
184	Sand ..	Fine sand	Sand ..	Quartz..	c	2·1	93·7	3·2	1·0	Poorly sorted sand containing pebbles of milky quartz, weathered basalt and sandstone.
186	Sand ..	Fine sand	Sand ..	Quartz..	c	..	78·9	18·9	2·2	
187	Sand ..	Medium sand	Sand ..	Quartz..	c	..	93·1	5·0	1·9	

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2 *continued.*

Station number.	Grade.	Predominant fraction	Textural class.	Predominant detrital mineral matter	Marine skeletal material	Gravel content (%)	Sand content (%)	Silt content (%)	Clay content (%)*	General Remarks.
191	Sand ..	Fine sand	Sand ..	Quartz ..	c	0·8	88·4	9·4	1·4	Poorly sorted sand containing fragments of basalt and ironstone.
193	Sand ..	Fine sand	Silty sand	Quartz ..	s	..	73·0	23·5	3·5	
195	Clay ..	Clay ..	Silty clay	Clay ..	S	..	10·5	25·7	64·8	Diver reported much sediment suspended in water.
197	Clay ..	Clay ..	Silty clay	Clay ..	S	..	1·7	23·4	74·9	
199	Clay ..	Clay ..	Silty clay	Clay ..	s		2·8	36·5	60·7	
200	Sand ..	Silt ..	Silty sand	Quartz ..	s	0·2	47·3	42·7	9·8	Poorly sorted sand containing small quartz pebbles.
201	Clay ..	Clay ..	Clay ..	Clay ..	c		1·9	12·1	86·0	
202	Sand ..	Medium sand	Sand ..	Quartz..	c	0·8	95·7	1·6	1·9	Poorly sorted sand.
204	Sand ..	Medium sand	Gravelly sand	Quartz..	a	18·4	69·5	8·4	3·7	Poorly sorted gravelly sand containing pebbles of ferruginous sandstone up to ½″ diameter. Diver reported submarine rock outcrop.
207	Sand ..	Coarse sand	Sand ..	Quartz..	a	2·2	93·1	3·4	1·3	Poorly sorted sand containing pebbles of ferruginous sandstone and ironstone.
208	Sand ..	Medium sand	Sand ..	Quartz..	c	..	90·6	6·8	2·6	Poorly sorted sand.
209	Clay ..	Clay ..	Silty clay	Quartz..	S	..	9·4	44·9	45·7	
210	Clay ..	Clay ..	Silty clay	Clay ..	S	..	2·3	47·5	50·2	
211	Clay ..	Clay ..	Silty clay	Clay ..	S	..	1·9	44·4	53·7	
212	Silt ..	Silt ..	Sandy silt	Quartz..	s	..	22·3	61·9	15·8	
214	Sand ..	Fine sand	Sand ..	Quartz..	A	..	98·1	1·5	0·4	Dune-limestone fragments present.
217	Sand ..	Fine sand	Sand ..	Quartz..	a	..	96·3	2·9	0·8	

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
223	Sand ..	Fine sand	Sand ..	Quartz..	a	..	97·2	1·6	1·2	Dune-limestone fragments present. Diver reported submarine rock outcrop.
227	Sand ..	Medium sand	Sand ..	Quartz..	A	0·3	98·8	0·5	0·4	Dune-limestone fragments present. Diver reported signs of scouring.
232	Sand ..	Medium sand	Sand ..	Quartz..	a	9·9	89·2	0·4	0·5	Fragments of dune-limestone present.
233	Sand ..	Very fine sand	Sand ..	Quartz..	a	..	80·1	14·1	5·8	
237	Sand ..	Fine sand	Clayey sand	Clay ..	A	11·2	70·1	5·3	13·4	Poorly sorted sand containing much weed.
238	Sand ..	Gravel ..	Gravelly sand	Quartz..	A	32·5	56·5	3·8	7·2	
239	Sand ..	Medium sand	Sand ..	Quartz..	a	1·2	97·3	1·1	0·4	
240	Sand ..	Fine sand	Sand ..	Quartz..	a	..	98·3	1·1	0·6	
241	Sand ..	Fine sand	Silty sand	Quartz..	c	..	74·8	12·7	12·5	
242	Sand ..	Fine sand	Silty sand	Quartz..	c	..	66·6	16·8	16·6	
243	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	55·9	30·1	14·0	
244	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	67·8	20·9	11·3	
245	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	74·4	16·3	9·3	
247	Sand ..	Fine sand	Sand ..	Quartz..	s	..	93·7	4·1	2·2	Poorly sorted sand.
248	Sand ..	Very coarse sand	Sand ..	Quartz..	s	13·6	83·5	1·0	0·9	Poorly sorted sand.
252	Clay ..	Clay ..	Clay ..	Clay ..	S	..	0·4	24·3	75·3	
253	Clay ..	Clay ..	Clay ..	Clay ..	S	..	0·5	17·6	81·9	
254	Clay ..	Clay ..	Sand-silt-clay	Clay ..	s	..	29·6	35·0	35·4	Biotite flakes conspicuous.
255	Sand ..	Very fine sand	Sand ..	Quartz..	s	..	79·6	12·1	8·3	Biotite flakes conspicuous.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
256	Sand ..	Coarse sand	Sand ..	Quartz..	c	8·0	90·9	0·6	0·5	Granite fragments and biotite flakes common.
257	Sand ..	Coarse sand	Sand ..	Quartz..	s	1·1	96·3	1·2	1·4	Well sorted sand containing ironstone particles and biotite flakes.
258	Sand ..	Very fine sand	Silty sand	Quartz..	s	..	53·0	32·4	14·6	Mica flakes conspicuous.
259	Clay ..	Clay ..	Clay ..	Clay ..	S	..	0·3	16·3	83·4	
260	Clay ..	Clay ..	Clay ..	Clay ..	S	..	1·6	7·9	90·5	
261	Clay ..	Clay ..	Clay ..	Clay ..	S	..	2·4	13·8	83·8	
262	Clay ..	Clay ..	Clay ..	Clay ..	S	..	0·3	7·0	92·7	
263	Clay ..	Clay ..	Silty clay	Clay ..	s	..	6·9	42·6	50·5	
266	Sand ..	Fine sand	Sand ..	Quartz..	a	5·9	91·1	1·1	1·9	Poorly sorted sand containing dune-limestone fragments.
269	Sand ..	Fine sand	Sand ..	Quartz..	a	0·9	96·2	1·6	1·3	
271	Sand ..	Medium sand	Sand ..	Quartz..	C	2·6	96·1	1·0	0·3	Diver reported sand movement with prominent ripple-marking.
274	Sand ..	Very fine sand	Silty sand	Quartz..	c	0·8	65·2	18·9	15·1	Diver reported ripple-marked floor.
275	Sand ..	Medium sand	Sand ..	Quartz..	A	1·1	97·9	0·4	0·6	Ferruginous sandstone fragments present. Diver reported ripple-marked floor.
276	Clay ..	Clay ..	Sand-silt-clay	Quartz..	S	..	25·5	36·9	37·6	
277	Clay ..	Clay ..	Clay ..	Clay ..	S	..	3·6	20·6	75·8	
278	Sand ..	Fine sand	Silty sand	Quartz..	s	..	60·8	31·3	7·9	
279	Silt ..	Silt ..	Sand-clay-silt	Quartz	s	4·7	20·9	38·2	36·2	
280	Gravel..	Gravel ..	Sandy gravel	Quartz..	C	55·7	43·8	0·3	0·2	Pebbles of ferruginous sandstone and ironstone common.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal [illegible]	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
281	Sand ..	Gravel ..	Gravelly sand	Quartz ..	C	32·5	64·5	1·9	1·1	Pebbles of ferruginous sandstone common. Diver reported submarine rock outcrop.
282	Clay ..	Clay ..	Silty clay	Quartz ..	s	1·4	1·7	46·7	50·2	
283	Silt ..	Silt ..	Sand-clay-silt	Quartz ..	s		26·8	46·0	27·2	Diver reported ripple-marked floor.
284	Sand ..	Silt ..	Silty sand	Quartz ..	a	11·4	59·8	23·9	4·9	Poorly sorted sediment containing pebbles of weathered basalt.
285	Sand ..	Medium sand	Silty sand	Quartz ..	c		69·1	15·6	15·3	Poorly sorted sediment.
286	Clay ..	Clay ..	Silty clay	Clay	S	..	1·6	45·6	52·8	
287	Clay ..	Clay ..	Sand-silt-clay	Clay	s	0·9	24·0	24·3	50·8	
289	Sand ..	Fine sand	Sand	Quartz ..	s	0·2	96·7	1·6	1·5	
292	Sand ..	Fine sand	Sand .	Quartz ..	c		96·3	1·5	2·2	Diver reported submarine outcrop of dune-limestone.
293	Sand ..	Coarse sand	Sand	Quartz ..	c	2·9	95·1	0·1	1·9	Dune-limestone fragments and quartz pebbles present. Diver reported submarine rock outcrop
295	Sand ..	Coarse sand	Sand	Quartz ..	c	2·5	96·2	0·1	1·2	Fragments of dune-limestone present.
296	Clay ..	Clay ..	Clay	Clay ..	s		16·6	8·2	75·2	
299	Clay ..	Clay ..	Clay ..	Clay ..	S		1·9	8·5	89·6	
300	Sand ..	Fine sand	Clayey sand	Quartz ..	c	0·5	68·8	8·7	22·0	
302	Clay ..	Clay ..	Clay	Clay ..	S		3·4	16·8	79·8	
303	Sand ..	Fine sand	Sand .	Quartz ..	a	.	97·6	1·0	1·4	Diver reported fairly strong current and ripple-marked floor.

* Clay content plus soluble salts and sometimes a little weed material.

TABLE 2.—*continued.*

Station number.	Grade.	Predominant fraction.	Textural class.	Predominant detrital mineral matter.	Marine skeletal material.	Gravel content. (%)	Sand content. (%)	Silt content. (%)	Clay content (%)*	General Remarks.
306	Sand ..	Fine sand	Clayey sand	Quartz..	S	..	58·3	15·4	26·3	
309	Clay ..	Clay ..	Silty clay	Clay ..	c	7·2	17·8	18·2	59·8	
311	Clay ..	Clay ..	Clay ..	Clay ..	S	..	1·4	10·9	87·7	
313	Sand ..	Coarse sand	Sand ..	Quartz..	c	9·0	86·6	0·5	3·9	Poorly sorted sand. Weed material fairly common.
314	Clay ..	Clay ..	Silty clay	Clay ..	S	..	5·6	19·8	74·6	
315	Clay ..	Clay ..	Silty clay	Clay ..	S	..	3·3	35·1	61·6	

* Clay content plus soluble salts and sometimes a little weed material.

Sediment Types.

Sediments can be classified according to several systems, depending upon the degree of refinement desired. In this study three classifications of sediment type have been selected: (1) grades (2) predominant fractions, and (3) textural classes.

Grades—The least refined classification is a series of only four categories, designated as grades. The four grades are: gravel, sand, silt, and clay. Grade designation for each sample is determined by that fraction most abundant in the sample. Size range and name of each grade are included in Table 1. The grade of each sample studied is listed in column 2 of Table 2.

Predominant Fractions—The classification of sediment types intermediate in degree of refinement is a group of categories termed predominant fractions. The particle-size category constituting the largest portion of the sediment sample is designated as the predominant fraction. Wentworth size classes listed in Table 1 are utilized for this classification. In column 3 of Table 2 is listed the predominant fraction of each sediment sample studied.

Textural Classes—The most refined classification of sediment types is termed textural classes. This is essentially a modification of the first classification (Grades). The most abundant grade, based on weight, is complemented by the second ranking grade, and the result is a binary term expressing the two major constituents of each sediment. An exception to this rule is when one grade constitutes 75 per cent. or more of any one sample. In such sediments the term is limited to a single grade. Among the samples analyzed, sand and clay are the only two classes that fall in this category. In sediments where three grades each provide 20 per cent. or more of the entire sample, all three grades are identified in the textural class terms. Sand-silt-clay and sand-clay-silt are the only representatives of this type of textural class encountered in this study. This procedure is in accordance with the system devised by Shepard (1953). The textural class of each sediment sample is listed in column 4 of Table 2; the geographic distribution is illustrated in Figure 1.

The most striking features of the textural class distribution have been mentioned above. Another major feature shown in Figure 1 is the extensive tract of silty sand located north of the Bellarine Peninsula and extending in a westerly direction to the shoreline and in a north-easterly direction as far as Williamstown. A further conspicuous feature is an extensive area of sand off the north-western shores of Port Phillip; it has a maximum width of $5\frac{1}{2}$ miles east of the Werribee River mouth where it extends out to depths of more than 6 fathoms, but it decreases in width considerably to the south-west, terminating bluntly about $\frac{3}{4}$ mile south of the Little River mouth. To the north-east this tract of sand extends as far as Altona, generally tapering in width; and, in the northern part, sand extends out to only about the 4-fathom line.

The central and western parts of Hobson's Bay and the area immediately to the south contain areas that have been deepened by dredging and also some regions where dredged material has been dumped.

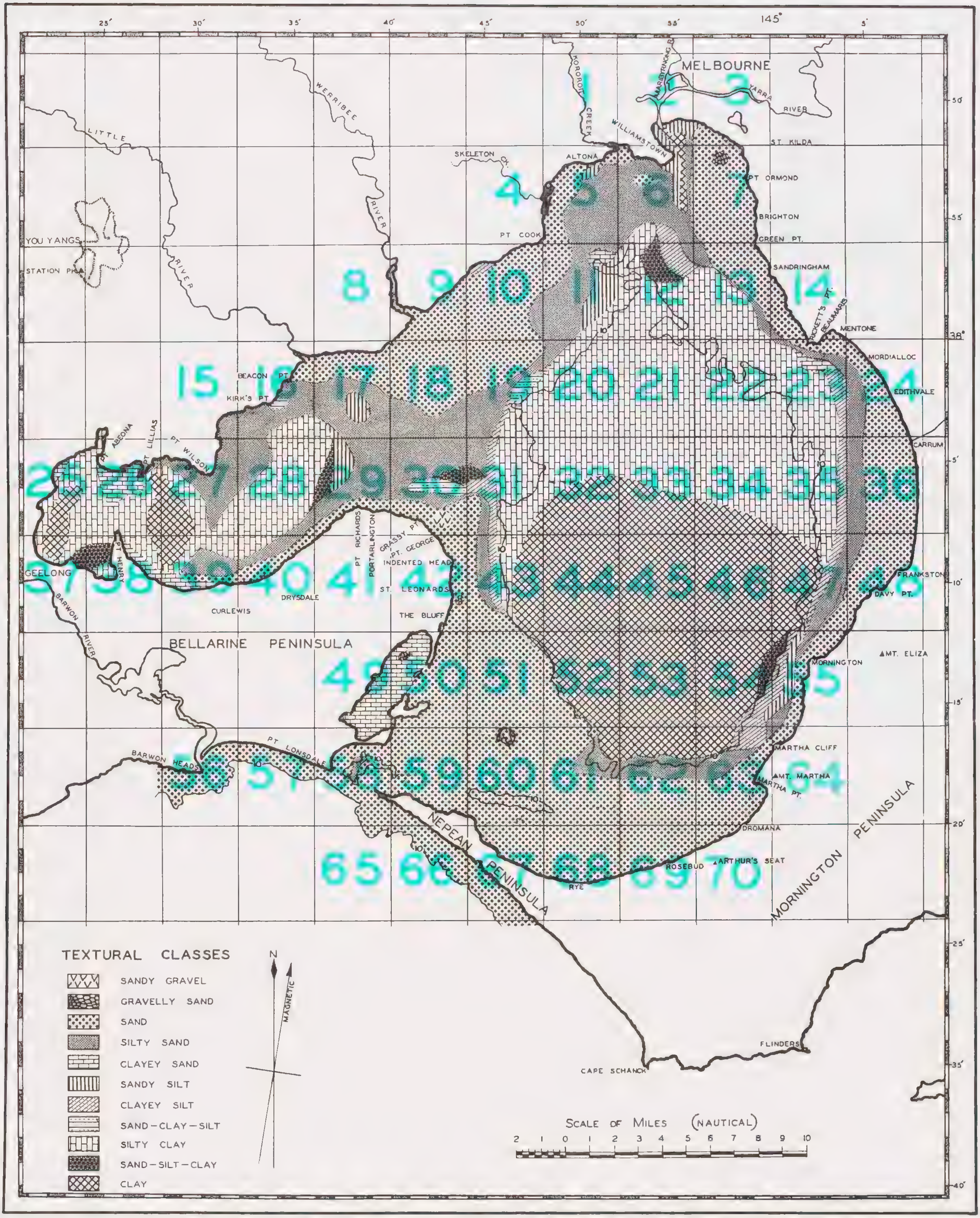


FIG. 1—Geographic distribution of sediment textural classes.

The sediments of the eastern part of Hobson's Bay and the area immediately to the south are sands, and sand extends almost as far west as the dredged Port Melbourne Channel. The floor of the shipping Channel is essentially clay, and, parallel to it, immediately to the east, there is a narrow belt of silty sand. Immediately to the west of the Port Melbourne Channel, sandy silt occurs in a narrow tract extending northwards to Williamstown. Sandy silt also extends from the western shore of Hobson's Bay to the dredged River Entrance Channel, as well as southwards offshore from between the Yarra mouth and Station Pier, Port Melbourne.

In the eastern part of Port Phillip there is a long, relatively narrow tract of silty sand roughly parallel to most of the eastern coastline; this belt occurs at an average depth of about 8 fathoms. To the east, this silty sand passes into sand and, to the west, between the latitudes of Mordialloc and Mornington, it passes into clayey silt. Elsewhere, on its western side, the silty sand passes into clayey sand, sandy silt, clayey silt and silty clay.

The belt of sand adjacent to the eastern shore of the Bay has a maximum width of $2\frac{3}{4}$ miles off Brighton. It is wide in the north-eastern part of the Bay where the bathymetric contours are far apart, but tapers in a south-easterly direction to a width of only $\frac{1}{3}$ mile off Rickett's Point where the bathymetric contours are closely spaced. South from Mentone this coastal belt of sand widens to a width of $2\frac{1}{3}$ miles off Carrum and Seaford and then gradually tapers to a width of less than $\frac{1}{2}$ mile off Mornington. Offshore between Mornington and Martha Cliff, where the bathymetric contours are very closely spaced near the shore, the coastal belt of sand averages about $\frac{1}{2}$ mile in width; but offshore between Martha Cliff and Martha Point the belt widens, enlarging considerably south of Martha Point.

To the west of the sandy belt between Mornington and Mount Martha, there are four sediment textural classes in an area approximately $5\frac{1}{2}$ miles in length by $1\frac{1}{2}$ miles in width. In this region, areas of silty sand, sandy silt and clayey silt abut on the coastal sand belt at different places. However, the silty sand is mainly in water shallower than the sandy silt, and the clayey silt in water deeper than the sandy silt. Offshore from Mornington, just west of and roughly parallel with the 10-fathom line, there is a lens-shaped area of sand-silt-clay, passing into clayey silt on its eastern side and into clay on its western side.

In the southern part of the Bay there is an east-west veering tract of silty sand approximately parallel with the 10-fathom line offshore between Dromana and Rye. This tract has an average width of $\frac{5}{8}$ mile and occurs at depths of about 8 to 10 fathoms. On its southern side the silty sand passes into sand, and on its northern side into clay.

In the deep water of Lonsdale Bight and the adjacent area near The Heads a narrow tract of silty sand occurs. Outside The Heads all of the bottom sediments examined as far as the 10-fathom line are sands, no sediments of finer grain-size being found. Admiralty Chart 1171 indicates that sand occurs to depths of more than 40 fathoms in Bass Strait.

Much of the north-east front of the Nepean Bay Bar is characterized by an abrupt change of sediment type from sand to clay, with either no intermediate textural classes or only very minor developments of certain classes. This abrupt change occurs at about the 10-fathom line, which for some long stretches is very close to the 6, 5, and 3-fathom lines. For about 2 miles the 10-fathom line is also very close to the 13-fathom line.

The large area of clay in the southern part of the Inner Basin passes into silty clay to the north and to the north-west. Almost all of the Bay floor enclosed within the 13-fathom line is covered by clay.

The bottom sediments of Swan Bay are essentially clayey sands but, in the northern part, gravelly shell sand is found. An area of gravelly sand also occurs near the shore east-south-east of St. Leonards.

Offshore from the north-eastern part of the Bellarine Peninsula a belt of silty sand extends in a north-south direction for about $4\frac{3}{4}$ miles, with sand on its western side and clayey silt on its eastern side.

The belt of sand adjacent to the north-eastern shores of the Bellarine Peninsula has a maximum width of $2\frac{1}{2}$ miles off Point George. This location is in Prince George Bank, a region which contains an area of sandy gravel as well as a number of submarine rock outcrops. The tract of sand adjacent to the northern shore of the Bellarine Peninsula from Grassy Point westward to about north of Curlewis is relatively narrow, averaging about $\frac{1}{2}$ mile in width. It passes into silty sand to the north, and tapers to extinction to the west.

About $1\frac{1}{2}$ miles offshore from the north-eastern part of the Bellarine Peninsula there is an elongate area of sand-clay-silt. It passes into silty sand to the south and west and into a lenticular area of sand-silt-clay to the north-east. Both the sand-clay-silt and sand-silt-clay areas pass on the east into clayey silt.

Adjacent to the southern shore of Geelong Outer Harbour, from about north of Curlewis nearly to Point Henry, there is a belt of clayey sand that averages about $\frac{1}{3}$ mile in width; for most of its length it passes into silty clay to the north.

A large area of clay occurs in Geelong Outer Harbour. It is roughly oval-shaped and elongated in a north-south direction, and approaches to within $\frac{1}{4}$ mile of the northern shoreline and about $\frac{3}{4}$ mile of the southern shoreline. This clay area is completely surrounded by silty clay, and silty clay extends for about 7 miles in a north-easterly direction. This silty clay passes mainly into silty sand to the north and south, but, in its most eastern part, it passes into a lenticular area of sand-silt-clay. This latter textural class is about 3 miles in length by $\frac{1}{4}$ mile in width, and passes into sandy silt and silty sand to the east. South of Point Wilson, a tongue-shaped area of silty sand extends from the shore for a distance of about $2\frac{1}{4}$ miles, and immediately to the south the belt of silty sand off the southern shore of Geelong Outer Harbour attains a width of $1\frac{1}{4}$ miles; a floor of silty clay about $\frac{1}{2}$ mile wide, part of which is a dredged channel, separates it from the tip of the Point Wilson "tongue". Accordingly, from Point Wilson southwards, silty sand extends nearly across Geelong Outer Harbour.

In Corio Bay there is also a large area of clay. It is elongated in a north-south direction and approaches to within $\frac{1}{8}$ mile of the southern shoreline and $\frac{1}{6}$ mile of the western shoreline. This clay area occurs almost entirely in water deeper than 5 fathoms, and part of it has been deepened by dredging operations. It is entirely surrounded by silty clay which extends for about $1\frac{1}{2}$ miles to the northern shore of Corio Bay and stretches in an easterly direction past Point Henry into Geelong Outer Harbour. In the shallow, south-eastern part of Corio Bay, known as Stingaree Bay, there is an area of sand-silt-clay, and this textural class passes into silty clay to the south and north. The south-eastern part of Corio Bay, west of the Point Henry Peninsula, contains a spoil ground and a considerable amount of dredged material has been dumped there. Adjacent to the north-western shore of Corio Bay there is a narrow tract of clayey sand, and clayey sand also extends southwards from the northern shore between Point Abeona and Point Lillias for distances up to $1\frac{1}{2}$ miles. Both areas of clayey sand pass into silty clay.

Approximately 2 miles south-west of the Little River mouth, adjacent to the shore, there is a small area of sand-clay-silt which passes into silty sand; and about $3\frac{1}{2}$ miles to the east of this there occurs a larger area of sandy silt completely surrounded by silty sand.

The large area of silty clay in the northern part of the Inner Basin extends landwards generally to depths of between 8 and 9 fathoms. Proceeding from south to north along its western margin, the silty clay passes into clayey silt, clayey sand, silty sand and sandy silt. The clayey silt occurs mainly as a narrow belt, and passes at its northern end into a lens-shaped area of clayey sand, situated about 9 miles east of the Little River mouth. This clayey sand extends in a north-easterly direction for about $2\frac{3}{4}$ miles and passes to the north into a region of silty sand. The sandy silt abutting on the north-western edge of the large area of silty clay extends northwards for about $3\frac{1}{2}$ miles; it has a width of about 1 mile and merges to the north into a small area of clayey sand. Abutting on the north-north-eastern edge of the silty clay there are areas of sand-silt-clay and clayey silt. The sand-silt-clay area passes to the north-east into a somewhat larger area of clayey silt which in turn passes into silty sand. To the south-east of these areas, and proceeding southwards, the silty clay passes, on its eastern margin, into relatively narrow tracts of silty sand, clayey sand and clayey silt. The clayey sand occurs as a lens-shaped area approximately 1 mile south of Rickett's Point; it is about 2 miles in length and has a maximum width of $\frac{1}{2}$ mile.

In the northern part of the Bay silty sand covers a large area. It extends from Williamstown southward for nearly 3 miles and has a width of $4\frac{1}{2}$ miles from about 1 mile east of Skeleton Creek mouth eastwards towards the dredged Port Melbourne Channel. The silty sand south of this Channel passes to the east into sand.

Content of Marine Skeletal Material.

Marine skeletal material (shell fragments, whole shells, echinoid spines, etc.) constitutes a large portion of the sediments in some localities. The relative abundance of marine skeletal material in each bottom sample was recorded by symbols, and is listed in column 6 of Table 2.

In general, high prevalence of marine skeletal material is associated with the coarser-grained sediments (sandy gravel, gravelly sand, sand and silty sand) and relatively shallow water. In relatively deep water and where the bottom is composed of fine-grained sediments, marine skeletal material generally is not common. The content of marine skeletal material is usually high in the vicinity of submarine rock outcrops and submarine accumulations of detached rock pebbles and boulders; commonly these rocks are fairly close to the shore.

Marine skeletal material is particularly prevalent in the bottom sediments of the Nepean Bay Bar, which is essentially an area of shoal water. This shoal water contains submarine outcrops of dune-limestone, and this rock, which itself contains much marine skeletal material, occurs as cliffs and rock platforms along the shore.

Marine skeletal material is very abundant in the sediment samples examined from Swan Bay, and is common in all samples examined from outside Port Phillip Heads (on the landward side of the 10-fathom line).

In most sediment samples obtained at depths of less than 6 fathoms off the eastern shores of the Bellarine Peninsula, marine skeletal material is quite prevalent, and it ranges from abundant to very abundant in bottom samples from Prince George Bank.

Close off the southern shore of Geelong Outer Harbour about north of Curlewis, marine skeletal material is common in the samples of sand and clayey sand, and it is also common in the clayey sand south-west of Point Lillias.

Offshore in the vicinity of Point Wilson and in the Spit region to the south, marine skeletal material is very abundant in the silty sand, and to the north-east of Point Wilson it ranges from common to abundant in the silty sand.

East and south of the Werribee River mouth, marine skeletal material is common in the sand samples, and offshore from Point Cook, also in sand, it ranges from common to very abundant. It is more prevalent in the samples from shallower water, closer to the shore, than in those from deeper water.

Offshore from Altona, marine skeletal material is abundant in the sand, and south of the mouth of Kororoit Creek, as well as to the south-east (off Williamstown), it is very abundant in the sand samples.

Marine skeletal material is common in the sand that occurs offshore from Port Melbourne, and it is abundant in the gravelly sand offshore from St. Kilda. In the sand samples examined from west of Brighton, marine skeletal material ranges from common to abundant, and it is common in the sand offshore from Sandringham.

In sand samples collected offshore between Edithvale and Seaford at depths of 5 fathoms and less, marine skeletal material is common, as also in the sand close to the shore between Canadian Bay (south of Frankston) and Mornington. At a depth of 3½ fathoms just south of

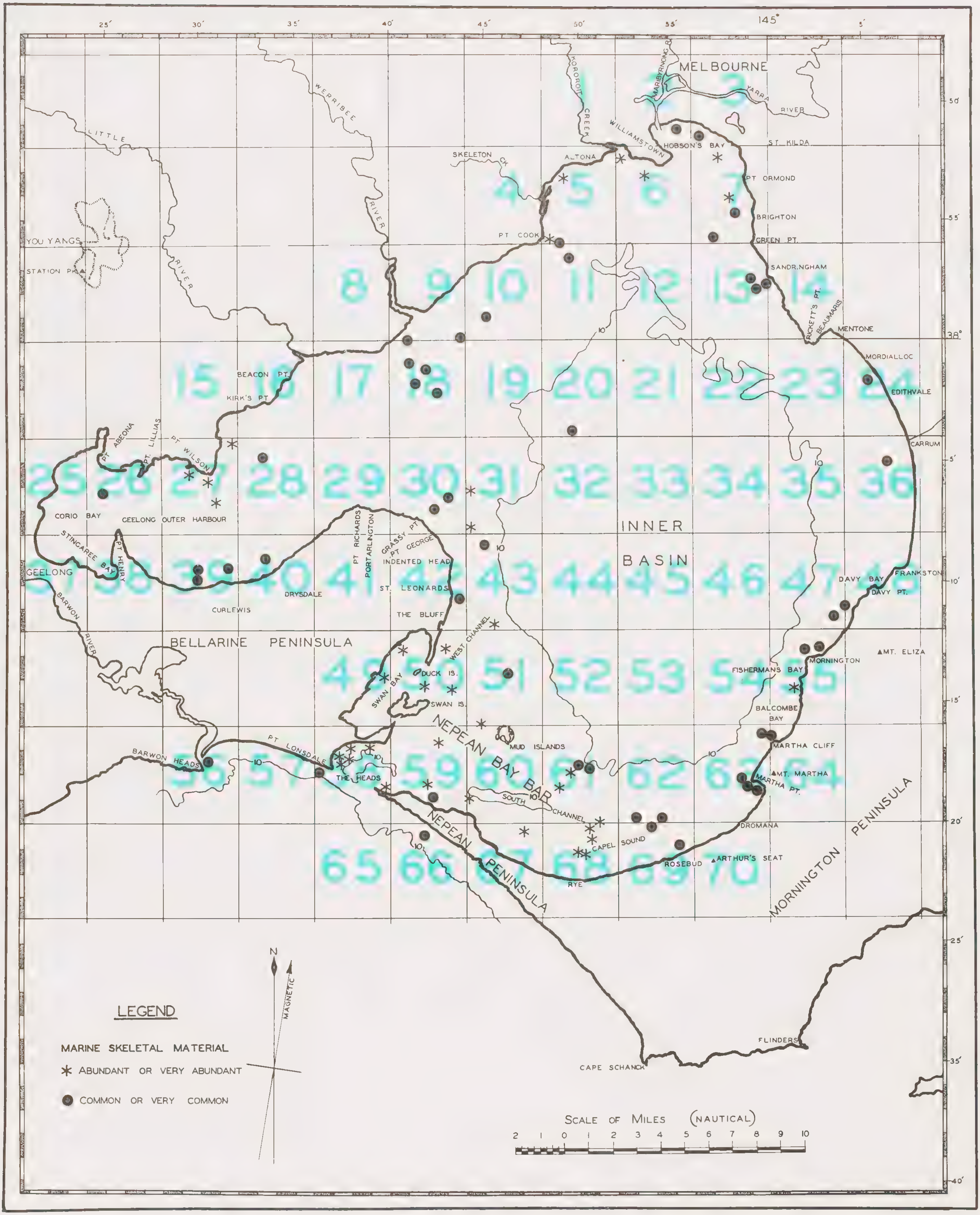


FIG. 2—Stations where prevalence of marine skeletal material is high.

Fisherman Point, Mornington, marine skeletal material is abundant in the sand, and it is common in the sand from depths of 5 fathoms and less off Martha Cliff. Shell fragments are also common in the sand samples obtained close to the shore off Martha Point and close off the granitic cliffs of Dromana Bay.

In the large area enclosed within the 10-fathom line, in the central part of the Bay, marine skeletal material is generally scarce or very scarce. It is common in only one of the samples examined; this is a sample of silty clay containing small whole shells, and was collected from about 8 miles south-east of the Werribee River mouth.

In other areas of silty clay and clay, such as occur in Geelong Outer Harbour and Corio Bay, marine skeletal material is also scarce or very scarce.

Weed Content.

Weed material was largely removed from the dry sample by hand picking with tweezers, and its relative abundance noted. In some samples, a little weed material was also removed and noted during decantation of the clay fraction.

The weed content of the dry samples of bottom sediments commonly reflects the relative abundance of weed growing on the various sediment textural classes in different parts of the Bay. In general, weed material was not common in the sand samples obtained by the skin-divers. It was found to be very scarce in the samples of silty clay and clay from the large areas of these textural classes in the deep, central part of the Bay. Generally, weed material was not common in samples obtained from depths greater than 5 or 6 fathoms.

Weed material was most common in samples of clayey sand and silty sand obtained from sheltered regions such as Swan Bay, parts of Geelong Outer Harbour and Corio Bay. It was also fairly common in certain samples of silty sand obtained offshore from the north-western coastline of the Bay.

Mineral and Rock Contents.

The detrital mineral matter predominating in each sediment sample is listed in column 5 of Table 2. In nearly all samples of sand, the predominant mineral is quartz. In samples from the belt of sand adjacent to the eastern shore, from Port Melbourne southward to about Balcombe Bay, the quartz grains are often ironstained and reveal films of brownish and yellowish secondary iron hydroxide along cracks and flaws; an abundance of ironstained grains has contributed to the overall yellowish colour of some of the sand samples.

In many of the sand samples obtained off the north-eastern shore of the Bay, between Port Melbourne and Mordialloc, fragments of ferruginous sandstone and ironstone are present; such samples generally are poorly sorted and some contain fragments of other rocks such as

chert and calcareous standstone. Submarine rock outcrops and accumulations of pebbles and boulders were reported by skin-divers in the vicinity of some of these sample locations. Heavy minerals constitute a small percentage of all the sand samples studied from this north-eastern part of the Bay; they are mostly opaque oxides—mainly black grains of ilmenite and magnetite and brown grains of limonite.

Many of the sand samples obtained offshore between Frankston and Balcombe Bay also contain fragments of ferruginous sandstone, and flakes of biotite are often conspicuous. On the Bay floor in this region, rock outcrops and accumulations of pebbles and boulders are not uncommon.

In samples obtained from the coastal belt of sand offshore from about Martha Cliff southwards to Rosebud, the quartz grains are usually not iron-stained, and this also applies to the sand samples from the Nepean Bay Bar area.

Off the granodiorite coast from Martha Cliff southwards to Safety Beach, Dromana, biotite flakes are conspicuous in the sand samples; and quartz and felspar granules, as well as granite, hornfels and quartz pebbles are present in some samples. Most of these sands are poorly sorted, as are those examined from the Dromana Bay area to the south.

About 1 mile offshore from Rosebud, pebbles of dune-limestone are found in the sand, and fragments of this rock are present in most of the sand samples obtained off the northern shore of the Nepean Peninsula between Sorrento and Point Nepean. Submarine outcrops of dune-limestone, ¼ mile offshore, were reported by the skin-divers in this region, as well as off Point Lonsdale and in the Lonsdale Bight between Point Lonsdale and Shortland Bluff, Queenscliff.

Outside Port Phillip Heads, fragments of dune-limestone are present in all the sand samples examined, and submarine outcrops of this rock were located up to ¾ mile offshore.

Dune-limestone fragments are also present in many of the sand samples obtained off the south-eastern part of the Bellarine Peninsula from Point Lonsdale northwards almost to St. Leonards, even being found as far as two miles offshore from just south of The Bluff.

Off the Bellarine Peninsula between The Bluff and Portarlington, fragments of ferruginous sandstone are not uncommon in the sand. The gravelly sand that occurs near the shore east-south-east of St. Leonards contains numerous pebbles of ferruginous sandstone, and a sandstone outcrop was found in the vicinity of station number 281. Submarine outcrops of ferruginous sandstone and accumulations of boulders and pebbles of this rock are particularly common off Indented Head and Point George. Fragments of ferruginous sandstone were found in the sand as far as 1½ miles to the east and 2¼ miles to the north-east of Point George, near the margin of the Prince George Bank. Dredging just south of the Prince George Light yielded quite large boulders of ferruginous sandstone. In the sandy gravel to the east of Grassy Point, granules and pebbles of ferruginous sandstone are very common and submarine outcrops of this rock were located.

Offshore from Portarlington, basalt fragments are present in the sand, and in the sand bordering the southern shore of Geelong Outer Harbour, about north of Curlewis, there are fragments of calcareous quartz sandstone. These sands generally are poorly sorted.

Fragments of weathered basalt occur in the silty sand off the northern shore of Geelong Outer Harbour in the vicinity of Point Wilson, and diving revealed submarine outcrops of basalt rising 2 feet above the floor about $\frac{1}{2}$ mile south of Point Wilson. In this silty sand, quartz grains are not very common. Fragments of decomposed basalt occur in the silty sand as far as $1\frac{1}{2}$ miles south of Point Wilson, and dredging operations about $2\frac{1}{4}$ miles to the south of Point Wilson have exposed solid basalt beneath silty clay.

To the north-north-east of Point Wilson and about $\frac{1}{2}$ mile offshore, fragments of weathered basalt occur in the silty sand. Diving has revealed a submarine outcrop of basalt at station number 172, about 3 miles south-east of the Little River mouth.

In the sandy sediments offshore between the mouth of the Little River and that of the Werribee River, granules and pebbles of vein quartz, weathered basalt, sandstone and impure limestone occur at various places, as far as 2 miles from the coastline. The sands of this region are generally poorly sorted and the quartz grains are commonly subangular. At station number 60, about $2\frac{1}{2}$ miles offshore, rock (? basalt outcrop) was reported by a skin-diver. Just north of the Werribee River mouth, basalt boulders and pebbles are found in the intertidal zone, and in the sand near the river mouth basalt fragments occur.

At station numbers 11 and 14, about 5 miles and 4 miles respectively to the east of the Werribee River mouth, small fragments of basalt are present in the sand.

Offshore from Point Cook, ferruginous sandstone, ironstone and basalt fragments occur in the sand samples collected from as far as $1\frac{1}{4}$ miles to the east-south-east of the Point. At station number 56, about $\frac{1}{4}$ mile east of Point Cook, the basalt pebbles range up to $1\frac{1}{2}$ inches in diameter. All sand samples examined from this region are poorly sorted. About $\frac{3}{8}$ mile east of Point Cook, a submarine rock outcrop believed to be basalt was reported by the skin-diver. Apparently this is part of the shallow rocky spit which, according to the "Australia Pilot", extends for approximately 1 mile eastward from Point Cook.

At station number 165, about $2\frac{1}{4}$ miles north-east of Point Cook, basalt granules occur in the silty sand; and basalt is present below silty sand at station 166, approximately $2\frac{1}{4}$ miles east-north-east of Point Cook.

About 1 mile east of Altona, fragments of weathered basalt occur in the sand, and the diver reported a submarine rock outcrop there. Another submarine rock outcrop, believed to be basalt, was reported in the vicinity of station number 65, approximately 2 miles south-east of Altona.

The silty sand at station number 200, about $2\frac{1}{4}$ miles south-south-west of Point Gellibrand, is poorly sorted and contains quartz granules and small quartz pebbles.

The sand and silty sand samples from off the north-western shore of Port Phillip Bay contain a small percentage of heavy minerals; the heavies are mostly opaque oxides—ilmenite, leucoxene, magnetite and limonite. However, grains of olivine, zircon, augite, rutile and tourmaline were recognized in some of the samples.

Clay minerals make up 75 per cent. or more of all the clay samples, and they constitute the predominant mineral matter in all except two of the samples of silty clay. Flakes of mica are conspicuous in some samples of silty clay from the northern portion of the large area enclosed within the 10-fathom line. Biotite flakes are conspicuous in the sand-silt-clay at station number 254, west of Mornington at a depth of 10 fathoms.

The shelly sands at station numbers 41 and 139, offshore in the vicinity of Point Wilson, have clay as their predominant mineral matter.

DISCUSSION AND INTERPRETATION.

Port Phillip Bay is an almost completely land-locked body of water with a bar of dune-limestone and sandbanks extending across its opening to the sea. It is believed to have existed more or less in its present form since mid-Holocene times. In mid-Holocene times, when the climate was slightly warmer than at present (Dorman and Gill, 1958), sea-level was of the order of 10 feet higher and the Bay was somewhat larger, covering low-lying, fringing regions particularly in the north-west.

For several thousand years sediment has been continuously deposited in the Bay and has been gradually accumulating. Sediments of terrigenous origin (mainly silts and clays) have been discharged from rivers into the Bay and carried to various areas in suspension and along the floor. Sediments derived from the marine erosion of the rocks and unconsolidated detrital materials around the Bay shores have gradually been spread over the bottom by wave action and currents. It appears to the writer that almost all these sediments have been effectively trapped in the Bay for 6,000 or 7,000 years. Evidence from the radiocarbon dating of wood (Gill, 1956) indicates that about 8,750 years ago the sea was at least 73 feet lower than now, so most of Port Phillip Bay is known to have been dry land at that time. Although no quantitative information is available concerning the rate of sedimentation on the Bay floor, it is considered that many of the bottom samples studied represent detritus of middle and late Holocene age; they consist only of the top 2 inches of sediment. However, some of the samples are believed to contain material of fluviatile origin, derived from the rivers that flowed over the floor of Port Phillip Bay before it was flooded by the sea 6,000 or 7,000 years ago. Such material of early Holocene and perhaps late Pleistocene age is considered to form part of the bottom sediments more particularly in certain areas,

such as those comparatively distant from the present shoreline and river mouths. With the gradual rise in sea-level which flooded Port Phillip Bay, there must have been much reworking of the detrital materials that covered the original floor. Reworking, with resorting and redistributing of some of these older sediments, by wave action and currents, is believed to have continued to the present time.

All of the samples of bottom sediments are unconsolidated, which is in keeping with a young age, and the clays and silty clays are comparatively soft. Unfortunately, the thicknesses of the various textural classes of sediment on the floor of the Bay are unknown until systematic coring is carried out. It is considered by the writer, however, that the thicknesses of certain bottom sediment types on some parts of the floor are fairly great.

The distribution of the various sediment textural classes generally appears to be related to the submarine topography. The clays and silty clays are found in the deep water, and the texture of the sediments usually becomes coarser as the water shoals. Distance from land and river mouths also appears to influence the sediment distribution. Usually there is a shoreward increase of grain size.

In sheltered parts of the Bay where there is little or no erosion of the coast, such as Swan Bay, Geelong Outer Harbour and Corio Bay, sediments of fine particle-size (clay, silty clay, clayey sand, &c.) occur in comparatively shallow water close to the shore. In these waters where currents are very weak and the power of wave action is usually restricted, fairly rapid sedimentation is apparent at certain places adjacent to the shore, and constant dredging of the shipping channels in Corio Bay and Geelong Outer Harbour is necessary to maintain them at a fixed depth. The clay and silt-size particles, which form such a large part of these bottom sediments, might partly have been (*a*) transported in suspension from other parts of the Bay, (*b*) brought into the areas by small streams nearby, and (*c*) derived from the marine erosion of rocks and unconsolidated detrital materials at certain places along the neighbouring coast. Many of the sand-size particles in the bottom sediments of these sheltered parts of Port Phillip Bay are fragments of marine skeletal material. In fact, shell fragments constitute nearly all the sand-size particles in the clayey sand of Swan Bay and the silty sand off Point Wilson, and they make up much of the sand and clayey sand adjacent to the southern shore of Geelong Outer Harbour. Although Tertiary sediments containing an appreciable content of quartz occur at certain places around the shores of Corio Bay and on the southern shore of Geelong Outer Harbour, many of the grains are of fine particle-size, and those of sand size liberated by marine erosion have generally not been transported far seaward. The fairly large areas of clay in Corio Bay and Geelong Outer Harbour occur in water generally deeper than that in which the silty clays occur, in keeping with the more normal distribution pattern of sediment types. The presence of the long "tongue" of silty sand that extends southward from Point Wilson appears to be related to the shoaling there; and the area of clayey sand that extends from the northern shore of Corio Bay southward for up to 1¼ miles appears also to be related to the occurrence of very shallow water.

Adjacent to the north-western shore of Port Phillip and for distances of up to about 5 miles seawards, conditions are usually quieter than in the eastern part of the Bay, since the prevalent winds which produce powerful waves come from the south-west, and the very gradual shoaling in this north-western region causes a dissipation of wave energy. As Jutson (1931) has observed, sedimentation is taking place along the north-western shore of the Bay and has been taking place for several thousand years; the area reclaimed by the mid-Holocene fall in sea-level has been added to by the accumulation of marine deposits at present sea-level. In this north-western region, extending from the shoreline seaward to depths of about 8 fathoms, the main sediment textural classes are sand and silty sand. The large area of sand to the east of the Werribee and Little River mouths has a delta-like form which, at least partly, appears to be due to sediment brought into the Bay by these rivers. Although normally they are relatively unimportant streams with shallow mouths, during periods of flooding their size increases considerably and they discharge appreciable quantities of detrital material into the Bay. At such times, as well as carrying clay and silt-size particles, they may transport some sand-size particles by rolling and saltation. It seems probable, however, that much of the sand to the east of the Werribee and Little River mouths is reworked material that originally came from these rivers in early Holocene and late Pleistocene times. The pebbles of vein quartz, sandstone and some of the other rock pebbles found in the sand as far as 2 miles offshore, most probably came from the ancestral Werribee and Little Rivers; they may have been derived from sub-basaltic gravels or other formations and have been transported and originally deposited during pluvial periods. Likewise, the pebbles of sandstone, quartz and basalt found in the silty sand up to 2 miles offshore from Point Cook and Point Gellibrand have probably come from the old rivers that flowed over the floor of the Bay before it was flooded by the sea about 6,000 or 7,000 years ago.

As Jutson (1931) considered, it is probable that some of the detrital material of fine particle size in the north-western part of Port Phillip Bay has come from the eastern side of the Bay by current and wave-action as well as from the Yarra and Maribyrnong Rivers since mid-Holocene times. The fact that basalt is the most common type of pebble in the sediment samples from this north-western part of the Bay is in keeping with the widespread occurrence of basalt on the adjacent land and its occurrence as submarine rock outcrops in the region. As mentioned above, fragments of basalt are found in the sand as far as 5 miles to the east of the Werribee River mouth. The generally higher content of marine skeletal material in the sands and silty sands off the north-western shore of the Bay compared with that off the eastern shore would seem to be due to the greater molluscan life in the quieter waters of the north-western region; the shell content is also significantly higher as the quartz grains in these sandy sediments are less abundant than in those off the eastern coast. The mineral species present in the small heavy fraction of the bottom sediments from the north-western part of the Bay suggest a mainly basaltic source, and it is probable that they were derived largely from the Newer Volcanic basalt.

The floor of certain parts of Hobson's Bay and of the area immediately to the south have been considerably affected by the dredging of shipping channels and the dumping of dredged materials; the original distribution of bottom sediment types has consequently been changed considerably. The catchment of the Yarra and Maribyrnong Rivers comprises 2,200 square miles, but by the time these rivers reach Melbourne they are normally sluggish streams which have lost their burden of sand but still carry much silt and clay. In the central and western parts of Hobson's Bay, the sandy silt, which is the predominant bottom sediment, appears to represent mainly river-borne detritus. The clay of the dredged shipping channels is considered to have been brought down by the ancestral Yarra in late Pleistocene and early to mid-Holocene times.

The sandy sediments of the eastern part of Hobson's Bay, and those of the continuation of this coastal belt to the south at least as far as Mordialloc, seem to have been derived mainly from the poorly consolidated Tertiary sandstones and Quaternary sands that occur as cliffs along the shore. Erosion is evidenced along this section of the coast by the need for erecting marine retaining walls, &c., at various places; and the common presence of submarine rock outcrops near the shore suggests that marine erosion and recession of the coastline has been taking place for a considerable time. The coastal erosion on this and other sections of the eastern side of the Bay seems to be caused almost entirely by the power of the waves formed by strong southerly and south-westerly winds. Tidal currents are relatively weak in the northern part of Port Phillip; the active currents are mainly longshore ones associated with strong winds. Although these currents are not important as erosive agents, they are of importance in transporting detrital material from place to place. Longshore drift of material near-shore is known to be considerable in this region.

Particularly after heavy rain in the Yarra River watershed, detrital material discharged into the Bay may be transported quite considerable distances southwards, to be added to the material supplied by wave erosion of the coast.

In this north-eastern part of Port Phillip the derivation of the coarser constituents in the sands and gravelly sands from the Tertiary sediments in the shore platforms and cliffs is apparent. Granules and pebbles of ferruginous sandstone, sandstone, ironstone and chert are quite common in the bottom sediments, and were found as far as $1\frac{1}{4}$ miles offshore. The actual presence of this coastal belt of sand composed mainly of ironstained quartz grains also suggests derivation from the adjacent Tertiary sediments, which have a high content of ironstained quartz grains. Carroll (1949, p. 107) found that the Tertiary brown sandstone at Beaumaris contained an average of 81 per cent. sand and 19 per cent. clay, and that the practically unconsolidated white sandstone undergoing rapid erosion in the cliffs at Mentone contained an average of 90 per cent. sand and 10 per cent. clay. The heavy mineral in these Tertiary sediments, described by Carroll (1949), also have a similarity with those observed in the sand samples from the north-eastern part of the Bay. Whincup (1944), in a paper dealing with the sand deposits between Brighton and Frankston, stated that "all the heavy minerals

found in the Tertiary deposits are also found in the sand ridges and beach deposits, with the addition of biotite in the beach deposits ". Carroll (1949) recorded that the quartz grains in the Tertiary sandstones at Beaumaris are commonly angular to subangular, those in the sandstone at Mentone having a higher degree of sorting. The writer's observations that the quartz grains in the bottom sediments of this north-eastern part of the Bay are usually not well rounded, and that the degree of sorting of the sediments is commonly low, are in keeping with a local derivation mainly from the sandy sediments of the cliffed coastline. The presence of bare submarine rock outcrops suggests active bottom-erosion in the comparatively shallow water of this region.

The mineral constituents of the belt of sand offshore between Mordialloc and Frankston probably were transported into the area mainly from coastal erosion of the rocks to the south and north. The presence of biotite flakes in these sandy bottom sediments suggests partial derivation from the granitic rocks to the south. Marine erosion of the sandy deposits that constitute this stretch of coast must also have contributed material to the sea-floor. In mid-Holocene times the sea extended over part of the low-lying plain to the east of the present coastline and, as the sea retreated with the mid-Holocene emergence, a considerable amount of detrital material must have passed through the wave-breaker zone, some being carried seawards. Reworking and redistributing of these older bottom sediments probably took place for a long time, and it is possible that some of these detrital materials are included in the bottom samples examined.

The comparatively narrow coastal belt of sand offshore between Frankston and Safety Beach, Dromana, appears to be composed of material derived essentially from the Tertiary sediments and Palaeozoic granitic rocks locally exposed in the cliffs and shore platforms. In all the sand samples examined from this region, there is a mixture of well rounded and of subangular to angular quartz grains, suggesting derivation both from the Baxter Sandstones and from the granitic rocks. Offshore from the sedimentary rocks, fragments of ferruginous sandstone and ironstone occur in many of the sand samples, while fragments of granodiorite are common in samples obtained offshore from the granodiorite. The biotite flakes, conspicuous in all samples from this section of the coastal sand belt, have evidently come from the Mount Martha granodiorite and the other granitic rocks. Flakes of biotite liberated from these igneous rocks have been transported long distances, being found also in the silty sand, sand-silt-clay and clayey silt to the west of the sand belt. The hornfels fragments in the sand offshore from Mount Martha have presumably been derived from the metamorphosed zone of Palaeozoic rocks surrounding the granodiorite exposures, while the quartz pebbles have come from quartz veins associated with these rocks. Marine erosion of the cliffed shoreline between Frankston and Dromana is active, and the presence of submarine rock outcrops close to the shore suggests that recession of the shoreline has been taking place for a considerable time.

The fact that the three sediment type zones of sand, silty sand and clayey silt off the eastern shore of Port Phillip Bay between Mentone and Mornington, are approximately parallel to the coastline suggests a definite relationship between sediment particle-size, water depth and distance

from land in that part of the Bay. Offshore between Mornington and Mount Martha, the presence of the elongate zone of sandy silt, fairly close to and roughly parallel with the coast, appears to be related both to water depth (relatively deep water occurring near the shore) and to the proximity of Tertiary sediments that contain a fairly high content of silt-size particles. The presence of the tract of clayey silt that occurs mostly to the west of the sandy silt in this area, may be related to greater water depth and greater distance from land; the silt and clay-size particles have presumably come largely from the Tertiary sediments.

The sand of Dromana Bay, with its relatively high content of subangular quartz grains and its low degree of sorting, has presumably been derived largely from the Mount Martha granodiorite and the granodiorite that outcrops along the shore at The Rocks, Dromana.

The sand of the Nepean Bay Bar, south of a line from Rosebud to St. Leonards, appears to have come chiefly from the marine erosion of the Pleistocene dune-limestone. Presumably some of the sand has come in from outside Port Phillip Heads, but such sand has similarly been derived from the dune-limestone. As indicated above, dune-limestone fragments are not uncommon in many of the samples examined from this part of Port Phillip Bay, and the content of shell material in the sand is quite high. At least part of this shell material has been shed from the disintegration of dune-limestone, since this rock is constituted mainly of particles of skeletal material of sand-size derived from marine organisms. The relatively low content of quartz grains in much of this sand is correlated with the low content of quartz grains in the dune-limestone. The presence of extensive submarine areas of dune-limestone swept free of sediment suggests that bottom-erosion is active. In this large area of shoal water where tidal currents are strong, movement of bottom sediments, by saltation, rolling and suspension, appears to be fairly extensive. This sediment movement has actually been witnessed by skin divers, and its results, in the form of shallowing and deepening of the water at different places, are apparent.

The sandy sediments off the north-eastern shores of the Bellarine Peninsula appear to have been derived mainly from the marine erosion of the locally exposed sedimentary rocks. This opinion is supported by the common presence of ferruginous sandstone fragments in the sand. The submarine outcrops of sandstone close to the shore suggest that recession of the shoreline through coastal erosion has been going on for a considerable time.

With reference to the samples of bottom sediments from the relatively deep, central portion of the Bay, it seems probable that part of the clay was originally deposited in early Holocene and late Pleistocene times. Keble (1946) interpreted the extensive area with an approximately level floor at 78 feet, north of the Nepean Bay Bar, as the delta of the ancestral Yarra River, and stated (p. 75) that " the mud on the delta, as elsewhere on the floor of the Bay, has, presumably, been brought down by the Yarra and its tributaries during the glacial stage, or equivalent pluvial stage, and resorted by the tidal streams during the interglacial and postglacial stages ". However, the writer thinks that part of the fine detritus constituting the large area of silty clay in the northern part

of the Inner Basin, represents material brought into the Bay by the rivers and derived through coastal and bottom erosion from middle Holocene times to the present day. The Tertiary sediments undergoing erosion along the shores of the Bay have a relatively high clay content. Some of the silt and clay derived from these sediments must have been transported seawards essentially in suspension and deposited in this relatively deep water.

Similarly, at least part of the very fine detritus constituting the large area of clay in the southern part of the Inner Basin evidently represents clay derived through coastal and bottom erosion, as well as some brought into the Bay by the rivers. The clay apparently remained suspended and was extensively distributed before deposition. The presence of this large area of clay in the deepest part of the Bay (apart from the scour-hole at The Heads) suggests a definite correlation with water depth. Fairly great distance from river mouths and from coastal source rocks that contain appreciable contents of silt-size particles, also appear to be significant factors influencing the occurrence of this clay area.

The occurrence of the fairly narrow belt of clayey silt that for considerable distances flanks the large areas of silty clay and clay in the Inner Basin seems to be related to shallowing water and closer proximity to land. Likewise, the occurrence of the zone of silty sand commonly present on the landward side of the clayey silt appears to have been controlled by the same factors.

The abrupt change of sediment type from the sand of the Nepean Bay Bar to the clay of the Inner Basin presumably is related to the steep slope of the north-east face of the Upper Dune Series described by Keble (1946). The bathymetric contour-lines are very closely spaced in this region and the water depth changes from about 3 fathoms to about 8 fathoms over quite a short distance.

Our knowledge of the hydrography of Port Phillip is too imperfect to adequately understand the relationships between water movements and sedimentation. Port Phillip is a relatively shallow bay, and wave motion capable of moving bottom sediments presumably extends to the floor over much of it, particularly during severe gales. In the shoal water of the Nepean Bay Bar, the combination of wave action and tidal currents has apparently brought about the fairly high degree of sorting of much of the sand.

Closer sampling and the detailed study of many more bottom samples from certain parts of Port Phillip is desirable. Such work would add considerably to information concerning Port Phillip bottom sediments presented in this paper.

ACKNOWLEDGMENTS.

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PORT PHILLIP SURVEY 1957–1963.

HYDROLOGY.

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SUMMARY.

Hydrological observations have been made in Port Phillip Bay during 1947–1952. Since the volume of water within the Bay is some ten times the combined annual river discharge of the flood period of 1952–1953, no complete freshwater scouring of the Bay can occur. Between 1947 and 1952 the chlorinity fluctuated each year from minimum values in November–December to maximum values in April–June, with a year by year decrease in the average annual value. This long term decrease was caused by increased river discharge, particularly during early summer when the chlorinity of the Bay normally increases by exchange with Bass Strait waters. Winter temperatures were warmest in 1950 and summer temperatures at their highest in 1951.

Nitrate nitrogen values were always less than 10 ug/1 in the centre of the Bay, elsewhere increased to as much as 360 ug/1 during increased river discharge. Inorganic phosphates of the Bay were generally less than 10 ug/1 in the centre and less than 20 ug/1 elsewhere. Quite often phosphates decreased during periods of increased river discharge. The Bay is well ventilated according to its oxygen characteristics. Oxygen values fluctuated around the saturation values except during extremes of chlorinity stratification when bottom values decreased to about 60 per cent. of the saturation values. Such decreases were quite rare however and in any case only of a temporary nature.

DATA AND METHODS.

(a) Sources of data.

The hydrological data were collected at six stations around the Bay (Chart 2 back of volume) during 1947–1952. Samples were collected at surface and depths to the bottom by officers of the Fisheries and Wildlife Department, Victoria and sent to the C.S.I.R.O. laboratory at Cronulla for chemical analysis. Delays of up to several days between collection and analysis of these samples could have caused errors in the nutrient analyses. The hydrological data have been published (C.S.I.R.O. 1952, 1953a, 1953b).

(b) Methods.

The chemical methods were described by Rochford 1951. The figures for inorganic phosphate have been used without salt correction, in this paper. Because of the small number of stations (Chart 2) it was not feasible to prepare charts of the horizontal distribution of hydrological properties of the Bay. In this paper the annual and year by year changes in these properties have been examined at two stations which are considered typical of the two extremes of hydrological environment of the Bay. Station 1 near the mouth of the Yarra River (Chart 2) is typical of the freshwater conditioned environment and Station 5 in the deep central basin is typical of the marine conditioned environment.

GENERAL FEATURES OF PORT PHILLIP BAY.

(a) Geological History.

Port Phillip Bay is part of a larger area called the Port Phillip Sunkland, formed by the down-faulting in Cainozoic times of the region between the Rowsley Fault in the west and Selwyn's Fault in the east. Subsequent flooding of part of this depressed, mainly low-lying area by the sea, due to the eustatic rise of sea level beginning in late Pleistocene and extending to mid-Holocene times, has given rise to Port Phillip Bay. It is believed that most of Port Phillip Bay was a land surface as recently as 7,000 years ago. Evidence from the radiocarbon dating of wood indicates that about 8,750 years ago the sea was at least 73 feet lower than now, so most of Port Phillip Bay is known to have been dry land at that time. The topography of the land before it was submerged has largely controlled the configuration and depth of the Bay.

In Pleistocene and early Holocene times the land surface was drained by a river system of which the Yarra River was part. The early Yarra flowed southwards over what is now the floor of Port Phillip Bay. Keble (1946, p. 73) has reconstructed the valley of the Yarra River during late Pleistocene and early Holocene times by connecting up soundings on Admiralty Chart 1171 into bathymetrical contour-lines; after this was done, the sunken river system showed up distinctly, and the Werribee, Little River, Kororoit Creek, and other streams now discharging into Port Phillip are seen to have been tributaries of the early Yarra. The eustatic rise of sea level drowned the lower part of the river system.

In Upper Pleistocene times, dune building established a bar across the " mouth " of Port Phillip, this is known as the Nepean Bay Bar.

In mid-Holocene times, when the climate was slightly warmer than at present, sea level was of the order of 10 feet higher and the Bay was somewhat larger, covering low-lying, fringing regions particularly in the north-west.

In the course of its geological history therefore, the volume of water within Port Phillip Bay has greatly increased but the area of drainage of its river systems has greatly decreased. Thus from an original freshwater dominated estuarine system the Bay has become progressively more saline and at the present time can absorb the quite large river discharges of 1952 without freshwater domination (page 109).

(b) Dimensions.

The total surface area of Port Phillip Bay inside of a line joining Point Lonsdale and Beacon Rock and excluding rivers is 568 square miles. Of this area about 30 per cent. is less than 5 fathoms (9·1 m.) deep. A central basin which is deeper than 10 fathoms (18·2 m.) has an area of 188 square miles and is cut off by a sill near the entrance from Bass Strait (Chart 2 back of volume). The volume of water in Port Phillip Bay at high water spring tide is 1507 x 10^4 acre feet (186 x 10^8 m^3). The combined annual discharge of all rivers into the Bay during a period of flood discharge in 1952–53 was 164 x 10^4 acre feet (State Rivers and Water

Supply Commission 1964). This is only about 10 per cent. of the volume of water in the Bay, which cannot therefore, be flushed completely of saline waters even during extreme flood conditions.

HYDROLOGICAL FEATURES.

(a) Chlorinity.

In the middle of the Bay the surface chlorinities were at a maximum in April–June and at a minimum in November–December (Fig. 1a, 1b). River discharges from the adjoining Werribee River were at a maximum in June–November and at a minimum in January–May (Fig. 1a–1b). Dilution of waters of the centre of the Bay was a function of river discharge during the dilution phase (Fig. 1c) but chlorinities remained at low values for some time after the diminution of river flow (Fig. 1c). The duration of this recovery period following dilution is governed by the rate of exchange of Port Phillip Bay and the adjoining Bass Strait waters and takes 4–6 months (A–A' Fig. 1c) to complete. Any further dilution during this recovery period cannot be compensated by this exchange process before the next winter dilution period (Fig. 1a) and a cummulative lowering of the average annual chlorinity results. This was a striking feature of the year by year changes in chlorinity at Station five during 1947–1952 (Fig. 2a). Despite a well marked annual recovery period, the average chlorinity decreased throughout this period paralleling an increase in river discharge (Fig. 2b). The extent of chlorinity recovery during January–May of each year was inversely proportional to the river discharge during this same period, during the years 1950–1952 (Fig. 2c). During 1949 however the chlorinity recovery was much weaker than the river discharge, based upon the above relation would indicate, and no satisfactory reason for this anomaly has been found. A striking feature of the chlorinity structure in the centre of the Bay was the near homogeneity of values in the 20 m. water column (Fig. 2a). This is in contrast to the chlorinity stratification found at Station 1 in only 5 m. of water (Fig. 3). During 1947–1952 the chlorinity of bottom waters at this station fluctuated seasonally in much the same fashion as those in the centre of the Bay with minimum values around September–October and maximum values around February–May of each year. The year by year average chlorinity decreased to a greater extent than did chlorinities of the centre of the Bay. Surface chlorinities at Station 1 fluctuated more widely than bottom values and showed a more pronounced year by year decrease.

(b) Temperature.

Typical annual cycles of surface temperature are shown in Figure 4. Temperature levels and the month by month changes were very similar at Stations 1 and 5. Vertical temperature stratification was most pronounced at Station 5 during the vernal-summer warming of surface waters (Fig. 5) but never exceeded a 3°C difference in 20 m.

At other stations in much shallower water temperature stratification of this order generally occurred only when there was a marked vertical gradient of chlorinity. Year by year changes in the maximum and minimum temperatures of the annual cycle were found (Fig. 5) with 1950 having the warmest winter and 1951 the warmest summer.

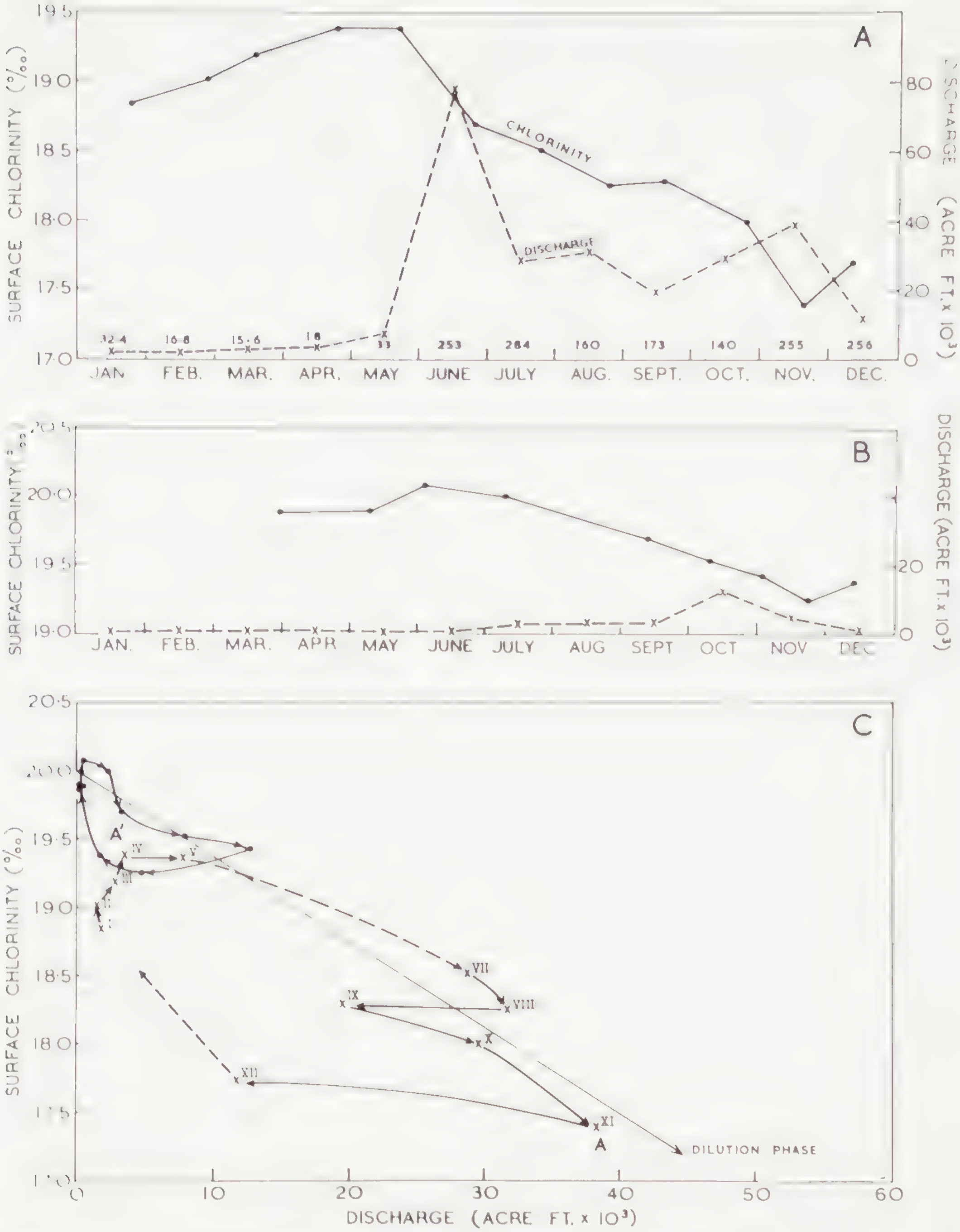

FIG. 1. A. Monthly changes in surface chlorinity at Station 5 (.———.) and in discharge of Werribee River at Melton Reservoir (x— —x) during 1952.

B. Same as 1A during 1947.

C. Surface chlorinity at Station 5 as a function of discharge of Werribee River at Melton Reservoir

·———· 1947

x——x 1952

Roman numerals indicate months.

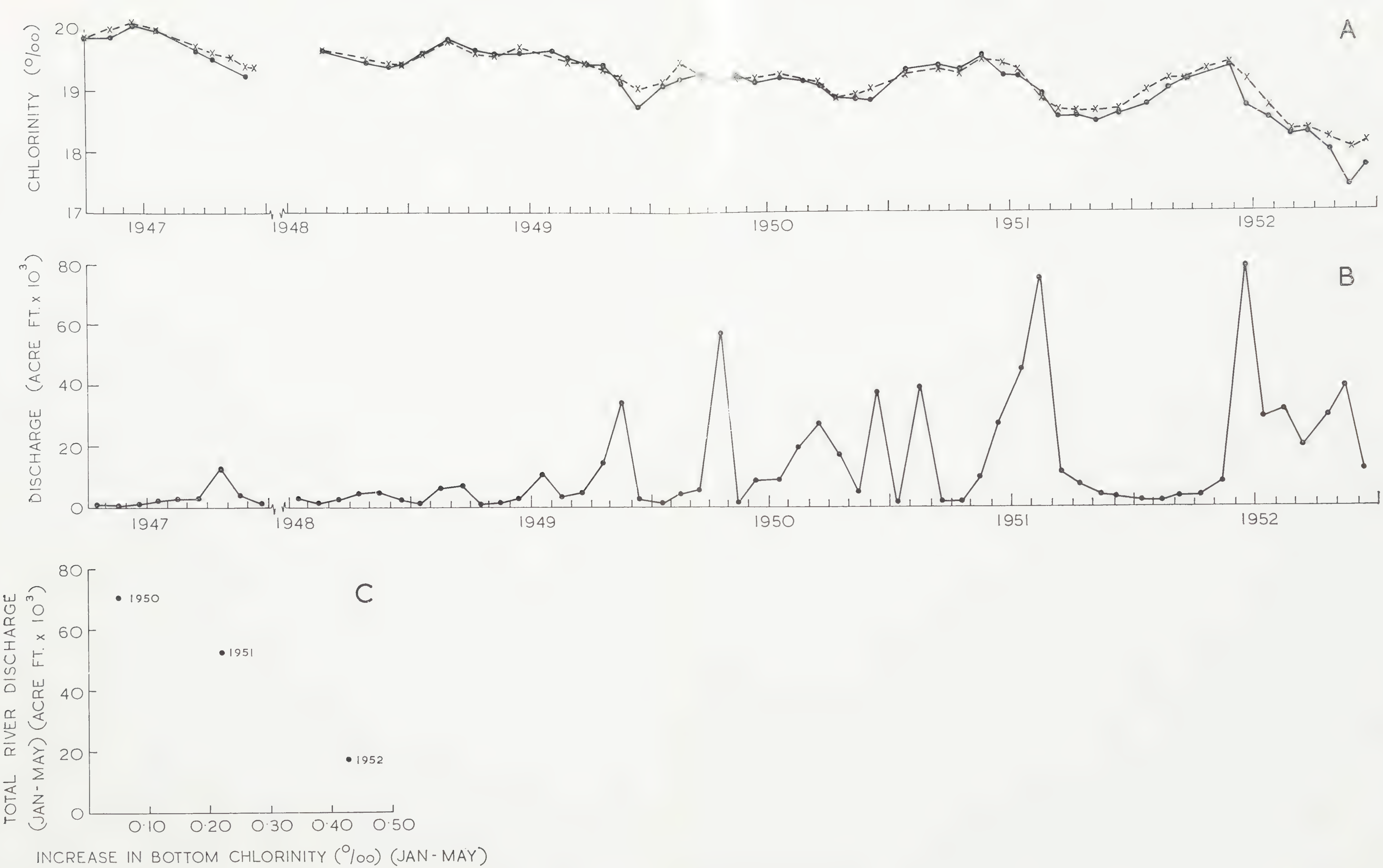

FIG. 2. A. The changes in surface (·) and 20 m. (x) chlorinity at Station 5 during 1947–52.
B. The changes in discharge of Werribee River at Melton Reservoir during 1947–52.
C. The increase in bottom chlorinity at Station 5 from January–May of 1950, 1951, 1952 in relation to changes in river discharge at Melton Reservoir during the same period.

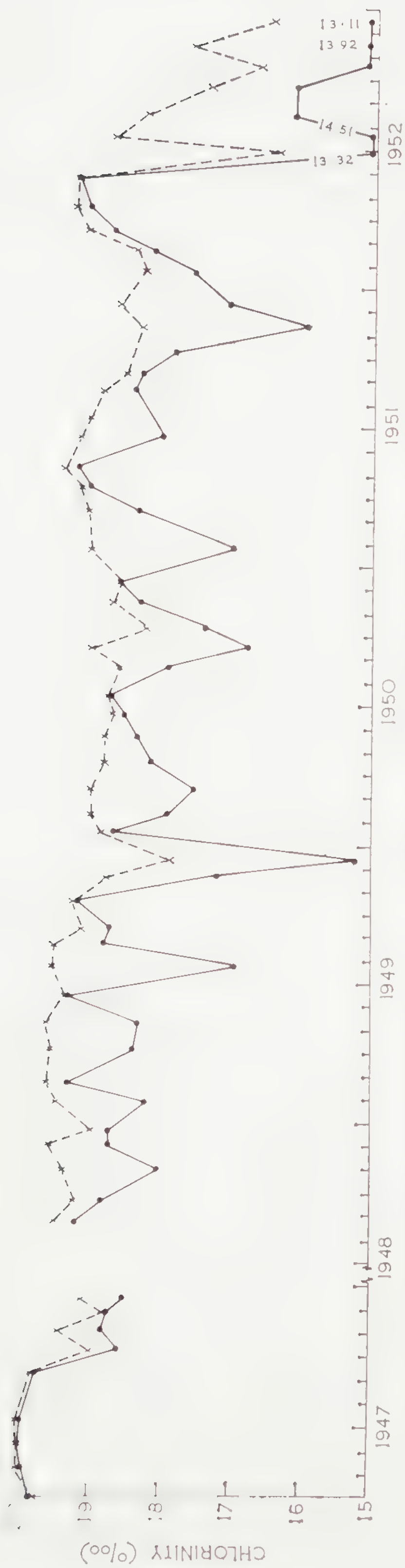

FIG. 3. The changes in surface (.——.) and 5 m. (x——x) chlorinity at Station 1 during 1947–52.

(c) Nitrate nitrogen.

In 1952 there was a pronounced annual variation in surface nitrates at Station 1 (Fig. 6a). During the chlorinity recovery period (January–May) nitrate concentrations were very low. With the onset of river dilution in June however, nitrate concentrations increased tremendously and were subsequently maintained at levels which were governed to a large extent by the outflow of the adjoining Yarra River (Fig. 6b). This annual variation also occurred in other years at Station 1, with the magnitude of the nitrate concentration largely dependent upon river dilution (Fig. 7). At Station 5 in the centre of the Bay however, nitrate concentrations were always less than 10 ug./1. (Fig. 7) and the average annual concentration particularly from 1950 onwards was not significantly increased by the decreased chlorinity during this period (Fig. 2a).

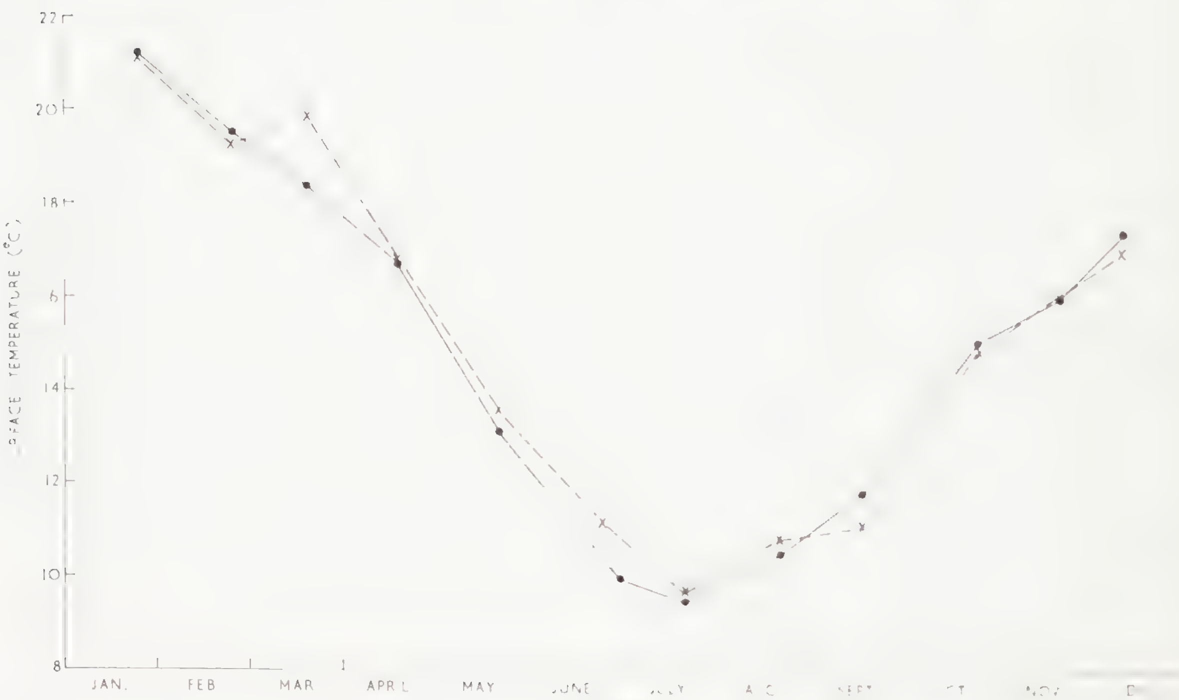

FIG. 4. The temperature changes in surface waters of Station 1 (·———·) and of Station 5 (x——x) during 1952.

(d) Inorganic phosphates.

At Station 5 during 1947–1952 phosphate fluctuated between 0–15 ug./1. (Fig. 8). There was no year by year increase in the average phosphate concentration similar to nitrate paralleling the decrease in chlorinity at this station (Fig. 2a). In point of fact the average phosphate concentration decreased from 1947–1952. Since the high chlorinities in 1947 at Station 5 were caused by greater amounts of Bass Strait water (page 109) it is probable that Bass Strait and not river waters are more important for the phosphate economy of the Bay. This is also shown by the year by year change in phosphates at Station 1 (Fig. 8)

FIG. 5. The changes in temperatures of surface (·——·) and 20 mm. (x——x) waters at Station 5 during 1947–52.

which is strongly influenced by river discharge (page 109). Between 1949 and 1952 at this station the average phosphate concentration decreased (Fig. 8) despite large increases in river discharge as evidenced by the decrease in chlorinity (Fig. 3).

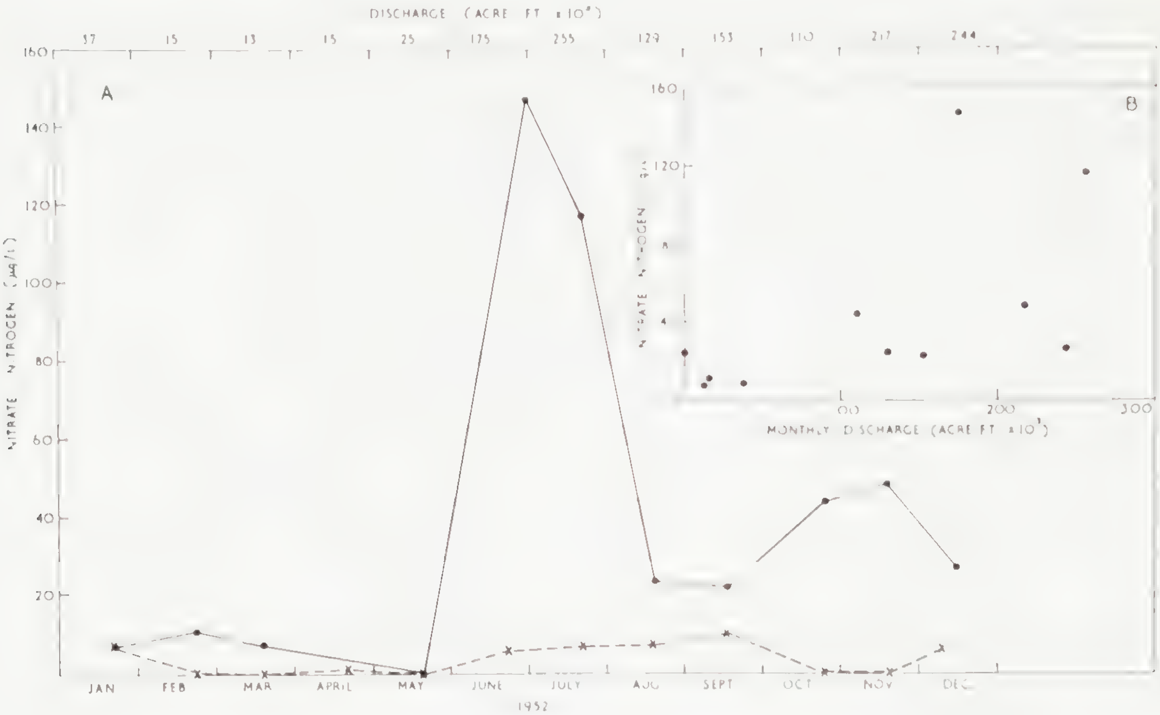

FIG. 6. A. Variations in nitrate concentration of surface waters at Station 1 (·———·) and Station 5 (x— — —x) during 1952. Figures along the top show the monthly discharge in acre ft. x 10^3 of the Yarra River at Yering during 1952.

B. The monthly nitrate concentration of surface waters at Station 1 as a function of Yarra River discharge during 1952.

(e) Oxygen.

Oxygen at Station 5 fluctuated from high values in winter to low values in summer (Fig. 9). Throughout these fluctuations the water generally remained nearly saturated with oxygen (Fig. 9) showing that these seasonal changes are mainly an effect of physical factors probably temperature upon the oxygen retaining capacity of the water. However, in December 1949, January 1952 and December 1952 the bottom waters had an oxygen content of some 85 per cent. only of the saturation value and biological utilization must have occurred.

At Station 1 the monthly changes followed (Fig. 10) somewhat the same seasonal pattern as at Station 5 but with a much greater annual range. Chlorinity stratification at Station 1 was much greater at certain times than at Station 5 (page 109). In general it was during these periods of stratification that the oxygen content of bottom

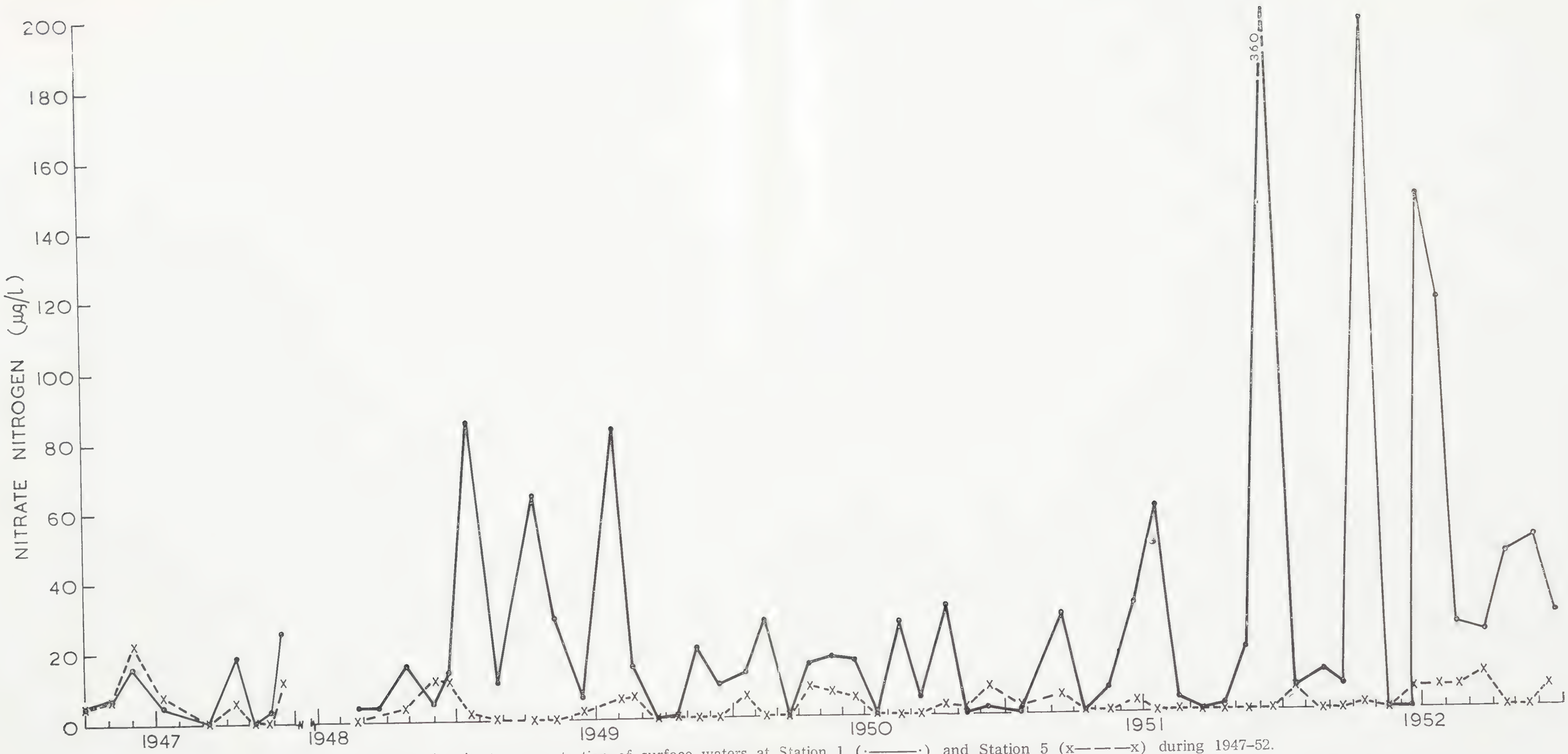

FIG. 7. Changes in nitrate concentration of surface waters at Station 1 (·———·) and Station 5 (x— — —x) during 1947–52.

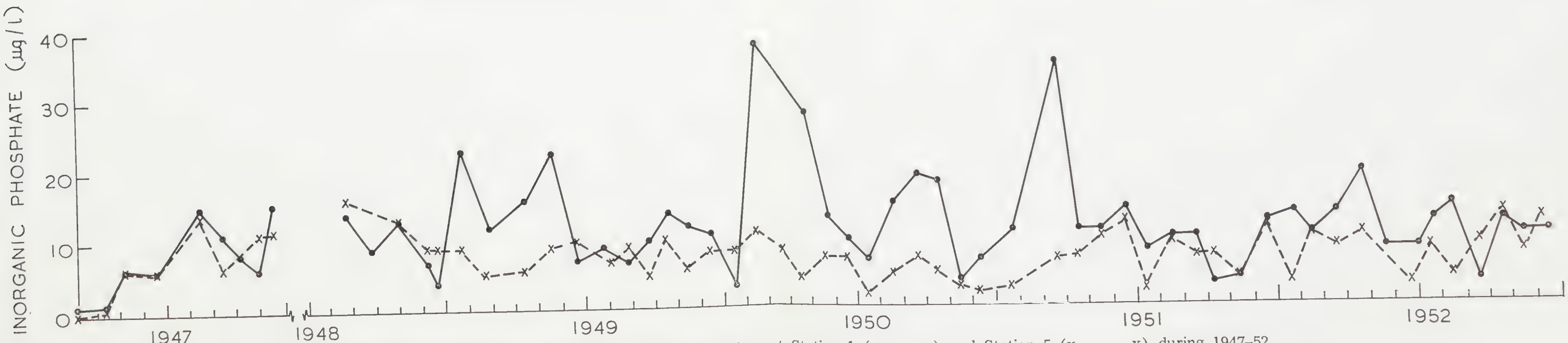

FIG. 8. Changes in phosphate concentration of surface waters at Station 1 (·———·) and Station 5 (x— — —x) during 1947–52.

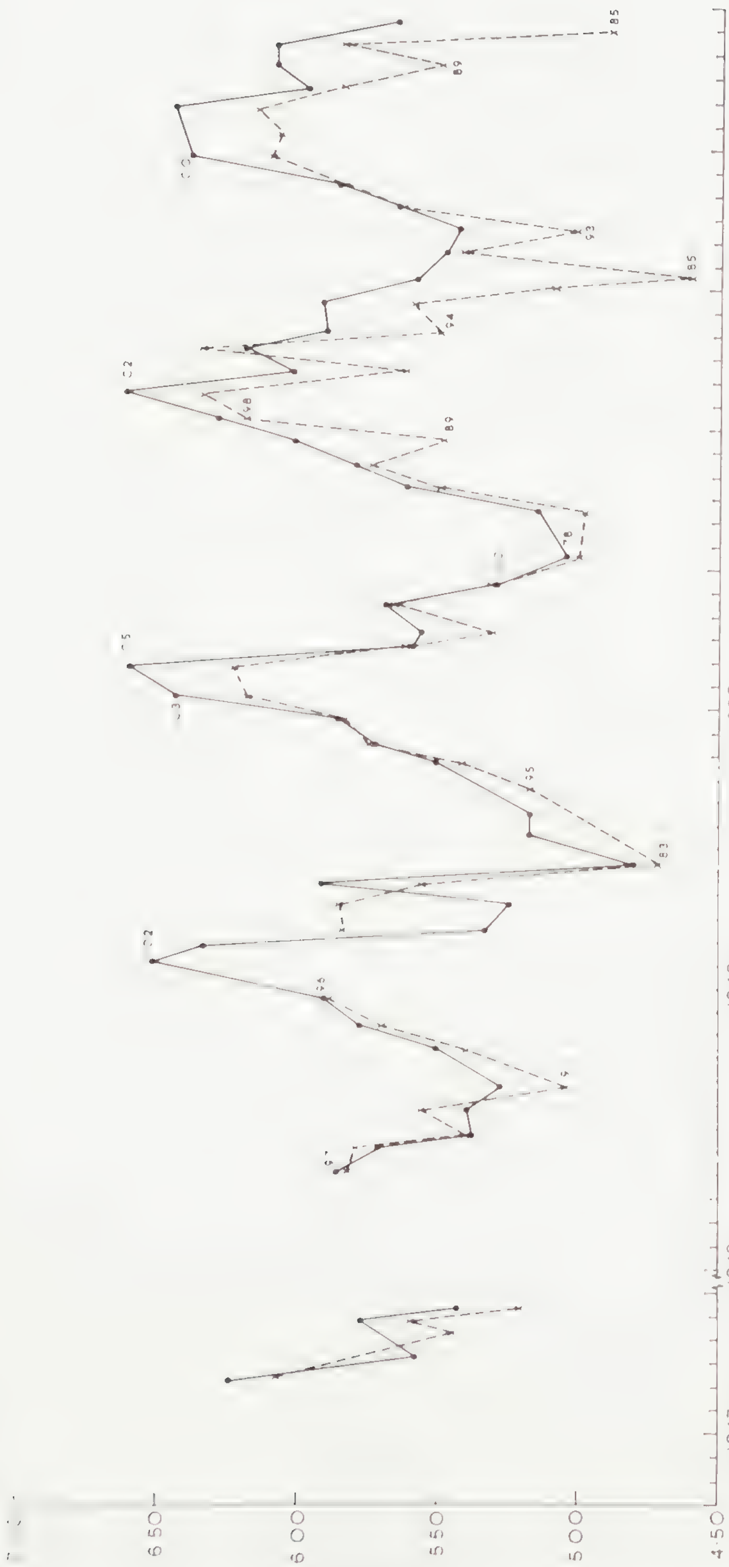

FIG. 9. Monthly changes in oxygen of surface (·——·) and 20 m. (x— — —x) waters at Station 5 during 1957–52.

FIG. 10. Monthly changes in oxygen of surface (·———·) and 5 m. (x———x) waters at Station 1 during 1947–52. Figures indicate oxygen percentage saturation value.

waters at Station 1 attained their lowest values (Fig. 11). This deoxygenation cycle is a feature of those estuarine systems in Australia (Rochford 1951) in which the bottom sediments contain easily oxidized substances such as ferrous salts and presumably such sediments occur at Station 1.

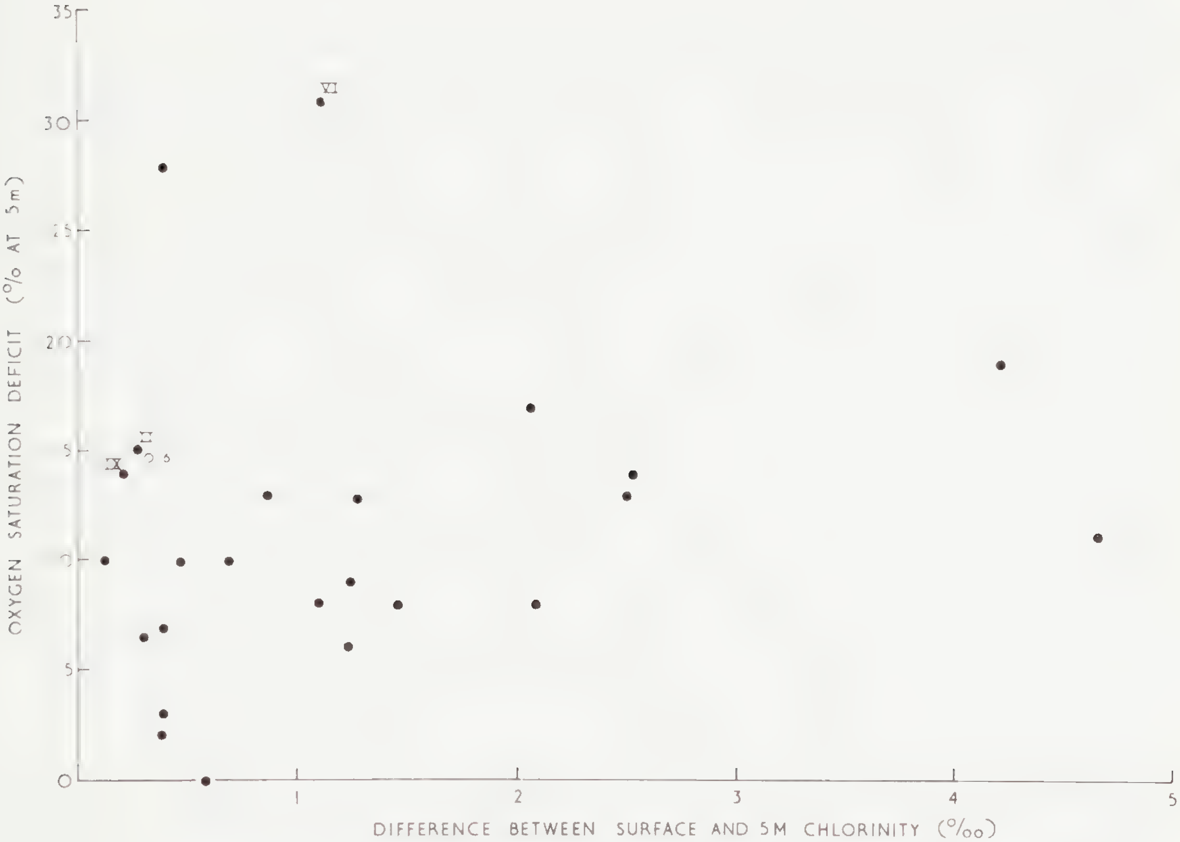

Fig. 11. Oxygen saturation deficit of 5 m. waters at Station 1 as a function of the difference in chlorinity at 0 and 5 m.

CONCLUSIONS.

(*a*) From 1947 to 1952 chlorinities of Port Phillip Bay decreased, because of increased river discharge, mainly during winter.

(*b*) After the winter dilution, some 4–6 months without further dilution is required to effect complete exchange of Bay and Bass Strait waters.

(*c*) The volume of water in the Bay is large enough relative to total river discharge to preclude any complete scouring of saline waters during floods.

(*d*) Concentration of nitrate nitrogen in Port Phillip Bay increases during periods of dilution.

(*e*) Inorganic phosphates in Port Phillip Bay decrease during periods of dilution.

(*f*) The seasonal changes in oxygen content of the Bay were largely caused by physical factors such as temperature, but at Station 1 in particular the oxygen of bottom waters was lowered by biological demand, whenever chlorinity stratification developed. However at no time did the oxygen fall below 60 per cent. of the saturation value.

ACKNOWLEDGMENTS.

The account of the Geological History was prepared by Dr. A. Beasley, to whom the author's thanks are extended.

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PORT PHILLIP SURVEY 1957–1963.

VEGETATION.

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SUMMARY

A brief historical account is given of the botanical collections, followed by discussion of the vascular flora and mosses living within the marine influence. This encompasses terrestrial and salt-marsh vegetation and submarine angiosperms. Lists of species and appropriate literature references are appended.

INTRODUCTION

Except for some historical references, the present account is concerned only with indigenous vascular plants and mosses that occur either in the water or along the bounding coastline of Port Phillip—a lineal distance of approximately 152 miles. The marine algae form the subject of a separate paper by a specialist in this group. If Bay-side vegetation be limited to those plants growing only within the influence of salt water (including high tides and driven spray), then the vascular flora would barely exceed 120 species; but a strip of land one mile wide all around the shore would embrace representatives of at least 550 species.

COLLECTORS AND INVESTIGATORS

No plant had been seen by white men on the terrain that is now Victoria before George Bass landed at Wilson Promontory in January, 1798, and James Grant visited Western Port in March, 1801, but there is a lack of evidence that either party collected botanical specimens. However, within four months of John Murray's discovery of Port Phillip Bay, on 5th January, 1802, Captain Matthew Flinders also sailed through The Heads accompanied by a botanical genius, Robert Brown.

During the week that H.M.S. INVESTIGATOR surveyed the southern parts of Port Phillip, Brown made the second recorded collection of Victorian plants. For the first collection credit must go to the French botanist, M. Leschenault de la Tour, who spent several days at Western Port with Captain Emmanuel Hamelin's party on LE NATURALISTE at the beginning of April, 1802, thus forestalling the discoveries of the Englishmen in Port Phillip by only a few days. Leschenault was impressed by the fertile appearance of the Western Port coasts, but said: "The number of plants which I gathered is not great." Robert Brown ascended Arthur's Seat (27th April, 1802), and examined the vegetation of Point Nepean peninsula, but was not present when Flinders and three crewmen climbed Station Peak (You Yangs) on May 1st. Brown returned to Port Phillip for another week's botanizing early in 1804, and he left for Hobart on the LADY NELSON (27th January) with the last party of evacuees from

Lieutenant David Collins's unsuccessful attempt to establish a settlement near Sorrento. It was unfortunate that Brown's only two sojourns on Victorian soil—both brief—should have been during summer and late autumn when floral activity was at a minimum; but among his trophies on the latter occasion was the showy Blue Pincushion (*Brunonia australis*) in a new monotypic genus bearing the Latinized form of the great collector's name. While the full extent of these earliest Victorian plant collections remains unknown, there is evidence that Brown either gathered from or noted about 100 species at Port Phillip; the type material of eighteen new species was involved, and his actual specimens of no less than 23 Port Phillip species are housed in the National Herbarium of Victoria (at South Yarra).

Neither surveyor Charles Grimes, who discovered the Yarra River (January, 1803), nor Hamilton Hume and William Hovell, who trekked overland from near Albury to Corio Bay (November–December, 1824), made any plant collections. But Ronald Gunn collected during " a short visit to the south coast of New Holland in March, 1835 " and in 1842 he published some observations on the flora of Geelong district—based on 100 species, of which only the genera are listed completely. This, apparently, was the first reference published in Australia to the plant-life of the Port Phillip region. James Backhouse, a visiting Quaker missionary, spent ten days in and around Melbourne during November, 1837; his narrative (published in 1843) certainly refers to several trees noted near the Yarra River mouth, but his contribution to early Victorian botany was negligible.

In the early 1840's Charles Joseph LaTrobe, Superintendent of the Port Phillip District and founder of Melbourne's Royal Botanic Gardens, interested himself in the local flora. Specimens of at least fourteen species, that he gathered on the heathlands between Melbourne and Brighton, are now represented in the Neuchatel Herbarium, western Switzerland. Also, between 1840 and 1855 an early Melbourne settler, F. M. Adamson, sent plant specimens to Sir William Hooker at Kew, England; some were from the shores of Port Phillip. In 1851 Daniel Bunce published a list of 201 species of the Victorian flora, including many from Port Melbourne, Brighton and other parts of the Bay.

Up until 1852, virtually all botanical (and other) collections had been taken out of the Colony to museums overseas; but the arrival from Adelaide, in August that year, of Dr. Ferdinand J. H. Mueller ushered in a new era for phytological research. Bringing with him a large private herbarium of European and South Australian collectings, also a useful reference library, young Mueller received the appointment of first Colonial Botonist on 26th January, 1853. Thereafter he threw himself into a survey of the country's flora with such zeal and efficiency that, within a decade, little remained anywhere for succeeding botanists to discover.

By 1861 this phenomenal man had built up in Melbourne a herbarium of 160,000 specimens that was long to remain the largest by far in the southern hemisphere. During 1862 appeared the first (and only complete) volume of his elaborate, illustrated PLANTS INDIGENOUS TO THE COLONY OF VICTORIA; a few species were quoted as from Port Phillip. In April, 1863, after just ten years in the Victorian Public Service, Mueller claimed that " the botanical investigation of the territory of our colony is now nearly completed "; and of course his investigation included most

of the species now known to occupy the coasts of Port Phillip. Up to the 1880's, botanical inquiry in Victoria became almost synonymous with Mueller's own activity in field and herbarium.

Of the very few other workers during the 25 year period 1853–78, mention may be made of Samuel Hannaford who brought out (1856) a catalogue of the Colony's commoner plants, and of Fanny A. Charsley whose 58 lithographic plates of Melbourne wildflowers in colour (1867) contained several undoubtedly coastal species, three being exclusively so.

G. H. Adcock's " Census of indigenous plants of the Geelong District " (1897), was probably the best attempt, until then, at a local flora in the Colony—with the possible exception of D. Sullivan's " Native Plants of the Grampians and Vicinity " which ran as a series through volumes 2 and 3 (1882–83) of the SOUTHERN SCIENCE RECORD, but which listed only ORCHIDACEAE among the monocotyledons. Dr. C. S. Sutton broke new ground in 1911 and 1912 by publishing the first ecological account of a major plant formation on the Bay-side: his " Notes on the Sandringham Flora " gave a detailed and informative account of Greater Melbourne's heath formation, with complete list of constituent species. In 1916 appeared Sutton's complementary and equally valuable contribution, " A Sketch of the Keilor Plains Flora "; this covered the basaltic terrain bounding the western side of the Bay. Both papers were published through the VICTORIAN NATURALIST, and drew attention to the alarming rate at which these tracts of vegetation were then disappearing. A warning of what was to come had already been sounded 30 years before by an anonymous writer in the SOUTHERN SCIENCE RECORD (Vol. 2, June, 1882):

> "Ominous signs of advancing settlement present themselves daily. Great notice-boards announcing sales of large areas, surveyors' pegs, landmarks and snobbishly-worded notices regarding trespassers, all justify the conviction that the once famous Brighton heath-grounds will shortly become a thing of the past. The collector will therefore do well to keep what specimens he finds, . . . in a few years these districts will be to the collector as a sealed book."

T. S. Hart's close acquaintance with the plant-life of Port Phillip is evident in several other papers to the Victorian Naturalist, notably on the protective value of coastal plants (1914) and a survey of the original extent of Yellow Box, *Eucalyptus melliodora*, near Melbourne (1939). In Professor A. J. Ewart's long-awaited FLORA OF VICTORIA (1931) sundry species are ascribed to the sandy heathlands and basalt plains adjoining Port Phillip. The latest and most advanced treatment of the vascular vegetation has been Dr. R. T. Patton's series of four important ecological studies—Cheltenham flora, coastal sand dunes, basalt plains and salt marsh—published between 1933 and 1942.

Meanwhile, the marine algae were not being neglected. The eminent phycologist, Professor W. H. Harvey of Trinity College, Dublin, spent four months in Victoria between August, 1854, and January, 1855, his chief collecting places on Port Phillip being at Brighton, Geelong and Queenscliff. These localities appear among others in the five volumes of his monumental PHYCOLOGIA AUSTRALICA ((1858–1863). S. Hannaford also collected some algae at Queenscliff and around Geelong between 1857 and 1863. During this period Mr. H. Watts provided observations and details of new species for Harvey's works and continued to investigate Port Phillip seaweeds into the 1880's, giving a number of algal lectures to the Victorian Field Naturalists' Club of which he was an early president.

Dr. J. Bracebridge Wilson who organized the collection of marine specimens for the biological survey of Port Phillip, from its inception in 1888 until his death in 1895, was an assiduous algologist; his dried material at Melbourne Herbarium spans the period 1879–95, and most of it came from near The Heads. Wilson's chief literary contribution was a "Catalogue of Algae collected at or near Port Phillip Heads and Western Port" (1892). Phycological researches were further advanced by H. T. Tisdall (1898 and 1900) and Profesor A. H. S. Lucas (1919 and 1931), while H. B. S. Womersley (1956, &c.) has more lately published numerous articles in which the seaweed flora of Port Phillip is involved.

R. A. Bastow gathered bryophytes and lichens—now in Melbourne Herbarium—from the Bay-side coasts at the turn of last century (1892–1905), while Dr. Ethel McLennan and Sophie Ducker have done pioneering work (1956) among the smaller soil fungi of heathlands.

MAJOR PLANT COMMUNITIES

Plates I–II.

The geological formations of the Port Phillip shore-line are varied, including as they do beach sand, dunes, calcareous eolianite cliffs, fluviatile sand (sometimes impregnated with iron and consolidated, forming bluffs where eroded by the sea), granite headlands, stony basalt plains and depositions of river alluvium. The rainfall varies from less than 17 inches per annum near Little River in the central-western sector of the Bay to 30 inches at Dromana in the south-east. Such diversity in climate and soil-types is reflected in the physiognomy and composition of the flora from place to place: there is grassland, woodland or open forest, heath, salt-marsh, also smaller aquatic, rheophytic, dune and cliff communities.

By far the two most extensive formations were the heath on deep fluviatile sand, stretching along the whole eastern coast from the mouth of the Yarra to Sorrento, and the grassland of the drier western basalt plains (between Newport and Geelong). Both have been discussed in detail by Patton (1933 and 1935).

The typical open heath, of ericoid shrubs in many plant families, blended often with a woodland in which the prevailing tree was a stunted form of *Eucalyptus viminalis* (the variety *racemosa*, principal food-plant of koalas near the coast). *E. ovata* was frequent on wet flats, accompanied by *E. camaldulensis* with increasing clay content in soils marginal to the heathland; extensive swampy areas, as at Carrum, were dominated by dense thickets of the paperbark, *Melaleuca ericifolia*, with associate aquatic herbs. There is evidence that the tea-tree, *Leptospermum laevigatum* (Pl. 1, fig. 1), an attractive and characteristic coastline tree all along the eastern side of Port Phillip, has been invading some areas of open heathland and reducing the species composition. In association with *Banksia integrifolia*, *Acacia longifolia* (var.), *Styphelia parviflora* and *Myoporum insulare*, it may frequently form a closed canopy, overhung by such creepers as *Tetragonia implexicoma* and *Clematis microphylla* and providing bower-like habitats for a few tender shade-loving species (including corticolous bryophytes and lichens, also fungi).

The heath proper was extremely rich in species, notably in the orchid, wattle, pea and epacrid groups, its facies at flowering time (July to October) recalling the colourful display of a West Australian sand-plain. Unfortunately this very attractive belt of vegetation, so interesting to the botanist, has been all but exterminated through suburban housing, draining of swamps and agricultural developments. The few inadequate and pathetic selvages that remain are being inexorably ruined by aggressive weeds that thrive on disturbed ground (e.g., alien species of *Briza, Ehrharta, Watsonia, Phytolacca, Oxalis, Salpichroa, Coprosma, Senecio* and *Chrysanthemoides*).

The basalt grasslands on the western side have also been profoundly altered through grazing, building operations and the influx of numerous weeds, (e.g., *Avena, Bromus, Diplotaxis, Trifolium, Lycium, Arctotheca, Cynara, Tragopogon* and many other members of Compositae). This tract of grassland was quite deficient in shrubs and very much poorer in species than the heath, to which it formed a striking contrast—the two formations were separated by salt-marsh and riparian scrub at the mouth of the Yarra.

Small occurrences of mangrove (*Avicennia marina*) accompanied the halophytic vegetation under tidal influence in Swan Bay and at the mouth of Kororoit Creek (near Seaholme), but *Avicennia* was virtually destroyed at the latter place by a thick deposit of oil discharged into the Bay about June, 1950—see comments by Willis (1951), and Fawcett (1951). Dominants of the saline marsh (pl. I, fig. 2) are chiefly members of the *Chenopodiaceae* (viz., succulent species of *Arthrocnemum, Salicornia* and *Suaeda*), but *Disphyma* (pl. II, fig. 1), *Frankenia, Wilsonia* and *Selliera* may each form extensive almost pure societies. This formation keeps remarkably free of weeds, *Atriplex hastata* being one of the few successful alien intruders. Patton has dealt with the coastal salt-marsh " in extenso " (1942), and also with the sand dune flora (1935)—a pioneer community of relatively few hardy species and some weeds (e.g., *Lagurus, Melilotus, Arctotis*). Marram Grass (*Ammophila arenaria*) has been deliberately planted on some unstable dunes to prevent sand drift.

Even more limited is the strand flora on beach sand within the influence of high tides. Only about seven species are concerned in this zone, the most interesting component being probably Coast Spinifex or Silver Grass (*Spinifex hirsutus*) (Pl. II, fig. 2) which sends its robust cord-like rhizomes for yards across the bare sand. Sea Wheat-grass, *Agropyron junceum*, is an introduction that occasionally serves to stabilize sand washed by high tides; it has been noted at Beaumaris, Seaholme, St. Leonards and Queenscliff. *Atriplex cinerea* and two species of *Cakile* (Sea Rocket) have a remarkable capacity for rapid colonization of loose beach sand.

The cliffy sections of the Bay exhibit a varied assortment of shrubs and herbs, some being confined to such habitats as are within reach of blown spray, e.g., *Alyxia buxifolia* and *Calocephalus brownii*. (Pl. II, fig. 2.) Many plants encroach onto sea-cliffs from the surrounding formations, notably heathland; and it is sometimes difficult to decide whether a particular species is to be regarded as an intruder or a natural component of the cliff flora. Some eucalypts and acacias are undoubtedly intruders, although they may reach the cliff-edge—perhaps through natural erosion

by the sea. Probably the rarest among Port Phillip's cliff-dwellers is *Lasiopetalum baueri*, of which only two old bushes are now known to survive (at Red Bluff, Sandringham).

SUBMARINE FLOWERING PLANTS

Of peculiar interest are the four species of phanerogams, all rhizomic monocotyledons, that grow permanently submerged in shallow sea-water. They comprise the two grass-wracks (*Zostera muelleri* and *Z. tasmanica*), sea-wrack (*Halophila ovalis*) and sea nymph (*Cymodocea antarctica*) which range widely along Australian shores. *Zostera muelleri* has been recorded from temperate waters of all States and also New Zealand, *Z. tasmanica* from South Australia, Victoria, Tasmania and New Zealand. *Halophila* is much more widespread, being known from all States, extending to tropical northern coasts and occurring also beyond Australia in parts of the Indian and western Pacific Oceans. *Cymodocea*, by contrast, is restricted to southern coasts of every State except Queensland. Mixed with various algae, detached fragments of these marine plants are often piled up on adjacent beaches during storms. In Port Phillip such drift material may often consist entirely of grass-wrack. (*Zostera*.)

The two *Zostera* species are grass-like plants with very narrow, flaccid, ribbony leaves, 1·5—5·0 mm. wide and from under 1 foot to nearly 3 feet long. *Z. muelleri* (leaves less than 1 foot long and 2 mm. wide) is commoner in the Bay than *Z. tasmanica*; but distributions overlap, and together these populations are dominant over a surprisingly large area of sandy shallows. From the accompanying map Chart 3 (back of volume), carefully prepared by Miss J. Hope Macpherson, their chief concentrations will be seen to extend around the north and south shores of Corio Bay, throughout the whole of Swan Bay and from thence northward to Indented Head, with detached occurrences off Mud Island, Rye, the Werribee River estuary and Altona. The whole eastern shoreline has only a few small, isolated and inconsequential beds of *Zostera*; but, at a conservative estimate, the total area of Port Phillip covered by grass-wrack would be at least 47 square miles.

Intimately associated as they are with inshore fisheries, the submarine "meadows" of *Zostera* are ecologically and economically important. E. J. Ferguson Wood (1959) has suggested that *Zostera* requires good illumination and does not thrive in turbid water. Consequently, it occurs mainly in shallows, from low water line to about 5 feet, and it may even be exposed to the air for a few hours during exceptionally low tides. About $1\frac{1}{2}$ miles east of Indented Head, however, grass-wrack beds extend out beyond the 5-fathom line to where the sea-floor begins to slope more abruptly toward 10 fathoms (at $1\frac{7}{8}$ miles). This occurrence, at depths exceeding 30 feet, must mark the absolute limit of low-illumination tolerance. After flowering has finished, at the end of summer, practically all foliage is shed; so, *Zostera* flats may appear to be quite bare during autumn and winter, although the subterranean rhizomes persist. Black swans are known to cause serious denudation of *Zostera* communities by tearing up the rhizomes over large areas (q.v. Wood, 1959). Owing to a complete lack of any previous information on the size and distribution

of these grass-wrack beds, it is not possible to say whether the extent of present occurrences indicates a recession, an expansion or a virtually static situation.

Halophila, with its oval or oblong leaf-blades (to 3 inches long) in pairs at each node of the rhizome, presents a very different picture. Generally speaking, it is submerged in deeper water than *Zostera* and will tolerate illuminations as low as 5—10% of the light intensity in surface layers. In Port Phillip *Halophila* occupies only a small fraction of the area covered by *Zostera*, occurring chiefly as narrow selvages along the outward fringe of *Caulerpa* (green algae) and *Zostera* beds; but this pattern may merely reflect an inability of *Halophila* to compete successfully with the other genera in shallower water.

Distribution of sea-wrack is practically confined to the western side of the Bay—from a belt ½ mile offshore and parallel to the eastern coast of Bellarine Peninsula to a longer zone 3–4 miles off the mouth of Werribee River, Corio Bay supporting several smaller occurrences. The range of *Halophila* is indicated on the map by finer, denser dotting.

Cymodocea is distinguished by its hard, wiry, naked stems (6–24 inches long) that carry a terminal cluster of shiny, distichous, broadly linear and truncated leaves, each 1–2 inches long. The reproductive mechanism is obscure but highly intriguing. Minute male and female flowers lie concealed within separate leaf-bases, and the pollen is extruded into sea-water as thread-like or vermiform cells, some of which reach the exserted filiform stigmas of female flowers. Bracts surrounding the latter enlarge in fruit to form a rigid cup (about 10 mm. wide) with four curved and comb-like lobes that serve effectively to anchor the embryo plant. Sea nymph, although usually growing on sand or mud beyond low water mark, may also favour rock pools in shallower water. Frequently the stems and foliage are encrusted with epiphytic growths of polyzoa and various algae. This plant is confined to the southern waters in Port Phillip, near The Heads, and the few areas that support it are too small to be mapped. However, in the Bunbury–Busselton area (West Australia) *Cymodocea* becomes a dominant marine plant in large beds, whence it is washed ashore to form pure drifts up to 6 feet wide and deep on the beaches of Geographe Bay.

Submarine flowering plants were collected during the course of the biological survey of Port Phillip Bay from the following localities. These are recorded as Areas with the station number in brackets immediately following:—

Zostera sp. Areas 5 (167–168); 6 (118); 10 (15); 16 (142–143); 26 (126–300); 27 (139); 28 (140); 39 (42–46, 313); 40 (101); 42 (264–5, 281, 288); 43 (263–303); 50 (229, 230, 233, 238, 267); 51 (250); 58 (89, 90–1, 150); 59 (214, 226); 60 (230–268); 61 (239); 66 (291); 68 (155, 158).

Halophila ovalis Areas 10 (14); 18 (62, 186, 307); 26 (300); 28 (141, 315); 39 (45); 40 (101); 42 (265); 50 (229, 267).

Cymodocea antarctica. Areas 43 (263); 50 (266); 58 (150–2); 59 (214); 66 (291).

Position of Areas and stations are shown on Charts 1 and 2 (back of volume).

Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171 Port Phillip, with the numbered Area grid superimposed.

Chart 2 shows position of the stations numbered 1–317, with the same grid super-imposed to aid in location of the stations and for correlation with depth, &c. Table A (back of volume) records station number, date, area, method of collecting (dive or dredge) and depth in fathoms.

LIST OF VASCULAR SPECIES GROWING WITHIN THE INFLUENCE OF SALT-WATER OR SPRAY.

(Arrangement is systematic, following the scheme of Engler & Prantl, 1887–1902.)

A. Submerged in sea water (4 species).

Zostera muelleri Irmisch ex Aschers.
Zostera tasmanica G. Martens ex Aschers.
Cymodocea antarctica (Labill.) Endl.
Halophila ovalis (R.Br.) Hook f.

B. Strand vegetation, on beach sand (7 species):

Spinifex hirsutus Labill.
Carex pumila Thunb.
Atriplex cinerea Poir.
Salsola kali L.
Tetragonia tetragonioides (Pallas) O. Kuntze
Cakile edentula (Bigel) Hook. subsp. *californica* (Heller) Hult.
Cakile maritima Scop. subsp. *integrifolia* (Hornem.) Hyland.

C. Salt-marsh and saline mud flats (43 species):

Ruppia maritima L.
Lepilaena preissii (Lehm.) F. Muell.
Lepilaena cylindrocarpa (Körnicke) Benth.
Triglochin striata Ruiz & Pav.
Triglochin mucronata R. Br.
Triglochin minutissima F. Muell.
Puccinellia stricta (Hook. f.) C. Blom.
Distichlis distichophylla (Labill.) Fassett
Zoisia macrantha Desv.
Sporobolus virginicus (L.) Kunth.
Scirpus cernuus Vahl.
Schoenus nitens (R.Br.) Poir.
Gahnia filum (Labill.) F. Muell.
Centrolepis polygna (R.Br.) Hieron.
Juncus maritimus Lam.
Juncus bufonius L.
Hemichroa pentandra R. Br.
Chenopodium glaucum L.
Atriplex paludosa R. Br.
Arthrocnemum arbusculum (R. Br.) Moq.
Arthrocnemum halocnemoides Nees. var. *pergrannulatum* J. M. Black. J. M. Black.
Salicornia australasica (Moq.) Hj. Eichler
Salicornia blackiana Ulbrich.
Suaeda australis (R. Br.) Moq.
Disphyma australe (Soland.) J. M. Black.
Sagina apetala L.
Spergularia media (L.) C. Presl.
Plagianthus spicatus (Hook.) Benth.
Frankenia pauciflora DC.
Hydrocotyle medicaginoides Turcz.
Samolus repens (Forst. & Forst. f.) Pers.
Limonium australe (R.Br.) Kuntze
Sebaea albidiflora F. Muell.
Wilsonia humilis R. Br.
Wilsonia rotundifolia Hook.
Wilsonia backhousei Hook. f.
Avicennia marina (Forst.) Vierh. var. *resinifera* (Forst.) Backh.
Mimulus repens R. Br
Pratia platycalyx (F. Muell.) Benth.
Selliera radicans Cav.
Brachycome graminea (Labill.) F. Muell.
Cotula vulgaris Levyns var. *australasica* J. H. Willis.
Angianthus preissianus (Steetz) Benth.

D. Dunes and sea-cliffs (68 species).

Pteridium esculentum (Forst.f.Nakai).
Poa poiformis (Labill.) Druce
Festuca littoralis Labill.
Dichelachne crinita (L.f.) Hook. f.
Agrostis billardieri R. Br.
Danthonia geniculata J. M. Black.
Stipa elegantissima Labill.
Stipa teretifolia Steud.
Stipa compacta D. K. Hughes
Stipa elatior (Benth.) D. K. Hughes
Scirpus nodosus Rottb.
Cladium junceum R. Br.
Lepidosperma gladiatum Labill.
Lomandra longifolia Labill.
Dianella revoluta R. Br.
Acianthus reniformis (R. Br.) Schlechter.
Caladenia latifolia R. Br.
Pterostylis cucullata R. Br.
Casuarina stricta Dryand. in Ait.
Banksia integrifolia L.f.
Amyema preissii (Miq.) van Tiegh.
Muehlenbeckia adpressa (Labill.) Meissn.
Rhagodia baccata (Labill.) Moq.
Enchylaena tomentosa R. Br.
Tetragonia implexicoma (Miq.) Hook. f.
Carpobrotus rossii (Haw.) N.E.Br.
Spergularia rubra (L.) J. & C. Presl
Clematis microphylla DC.
Hymenolobus procumbens (L.) Nutt. ex J. M. Black.
Crassula sieberiana (Schult. & Schult. f.) Druce.
Bursaria spinosa Cav.
Acaena anserinifolia (Forst. & Forst. f.) Druce.
Acacia longifolia (Andr.) Willd. var. *sophorae* (Labill.) F. Muell.
Acacia retinodes Schlechtendal var. *oraria* J. M. Black.
Pultenaea tenuifolia R. Br.
Lotus australis Andr.
Swainsona lessertiifolia DC.
Kennedia prostrata R. Br. in Ait. f.
Geranium pilosum sens, lat. (non certe Forst. f.).
Pelargonium australe Willd.
Oxalis corniculata L.
Zygophyllum billardieri DC.
Correa alba Andr.
Adriana klotzschii (F. Muell.) Muell.-Arg.
Adriana quadripartita (Labill.) Gaudich.
Stackhousia spathulata Sieber ex Spreng.
Lasiopetalum baueri Steetz in Lehm.
Pimelea serpyllifolia R. Br.
Melaleuca pubescens Schauer in Walp.
Leptospermum laevigatum (J. Gaertn.) F. Muell.
Apium prostratum Labill.
Styphelia parviflora (Andr.) Lindl.
Alyxia buxifolia R. Br.
Dichondra repens Forst. & Forst. f.
Solanum laciniatum Ait.
Myoporum insulare R. Br.
Lobelia alata Labill.
Olearia axillaris (DC.) Benth.
Olearia ramulosa (Labill.) Benth.
Olearia glutinosa (Lindl.) Benth.
Brachycome parvula Hook. f.
Calocephalus brownii (Cass.) F. Muell.
Cassinia spectabilis (Labill.) R. Br.
Helichrysum paralium (N. T. Burbidge) W. M. Curtis
Helichrysum leucopsidium DC.
Senecio lautus Forst. f. ex. Willd.
Senecio odoratus Hornem.
Sonchus megalocarpus (Hook. f.) J. M. Black

A few species occur on cliffs just outside the Port Phillip Heads, but have not been noted in the Bay proper, viz: *Threlkeldia diffusa* R. Br. *Pultenaea canaliculata* F. Muell., *Beyeria leschenaultii* (DC.) Baill., *Pomaderris oraria* F. Muell. ex Reiss., *Senecio orarius* J. M. Black.

MOSSES.

The moss-flora of Port Phillip shoreline is relatively poor in species, all being common and widely distributed plants elsewhere; but published references to these occurrences are very meagre, if they exist at all. The eastern coast, with its cliffy terrain, surviving thickets of *Leptospermum* and other small trees, supports a far greater percentage of bryophytes than the flatter, drier, exposed western shore. Every moss in the following list

of 29 species has been identified by the author whose locality records are also indicated. More intensive work, especially in the vicinity of the Heads, will doubtless bring to light additional records.

Brachymenium preissianum (Hampe) Jaeg.—Sorrento.

Breutelia affinis (Hook.) Mitt.—Frankston, Edwards Point (Swan Bay).

Bryum argenteum Hedw. Port Melbourne, Sandringham and Beaumaris

Bryum billardieri Schwaegr.—Sandringham, Beaumaris, Frankston, Martha Point, Rosebud, Sorrento, Mud Islands, Edwards Point.

Bryum chrysoneuron C. Muell.—Port Melbourne.

Bryum capillare Hedw.—Rosebud, Sorrento.

Bryum dichotomum Hedw.—Port Melbourne, Sandringham, Beaumaris.

Campylopus introflexus (Hedw.) Brid.—Sandringham, Beaumaris, Frankston.

Campylopus clavatus (R. Br.) Hook. f. & Wils.—Edwards Point.

Ceratodon purpureus (Hedw.) Brid.—Sandringham, Beaumaris, Martha Point, Sorrento, Mud Islands, Edwards Point.

Desmatodon convolutus (Brid.) Grout.—Sandringham, Martha Point.

Fissidens pungens C. Muell. & Hampe (var.)—Sandringham, Beaumaris.

Fissidens taylori C. Muell.—Sandringham, Beaumaris.

Fissidens vittatus Hook. f. & Wils.—Martha Point.

Gigaspermum repens (Hook.) Lindb.—Sandringham.

Gymnostomum calcareum Nees, Hornsch. & Sturm.—Sorrento.

Pleuridium nervosum (Hook.) Par.—Sandringham, Beaumaris.

Polytrichum juniperinum Hedw.—Edwards Point.

Pottia davalliana (Sm.) C. Jens.—Queenscliff.

Rhacopilum convolutaceum (C. Muell.) Mitt.—Frankston, Rosebud, Sorrento.

Rhynchostegium tenuifolium (Hedw.) Jaeg.— Sandringham, Beaumaris, Rosebud.

Sematophyllum homomallum (Hampe) Broth.—on tree-trunks at Sandringham, Beaumaris, Frankston, Rosebud, Edwards Point.

Thuidium furfurosum (Hook. f. & Wils) Jaeg.—Sandringham, Beaumaris, Frankston, Rosebud Sorrento, Edwards Point.

Tortella calycina (Schwaegr.) Dixon—Sandringham, Beaumaris, Martha Point, Rosebud, Sorrento, Mud Islands, Edwards Point.

Tortula muralis Hedw.—on cement-works, bricks, &c., at Brighton, Sandringham, Beaumaris, Rosebud.

Tortula papillosa Wils. ex Spruce—on tree-trunks at Sandringham, Beaumaris, Sorrento, Mud Islands.

Tortula princeps (C. Muell.) DeNot.—Rosebud, Sorrento, Edwards Point.

Triquetrella papillata (Hook. f. & Wils.) Broth.—Brighton, Sandringham, Beaumaris, Martha Point, Rosebud, Edwards Point.

Zygodon minutus C. Muell. & Hampe.—on tree-trunks at Sandringham, Beaumaris, Frankston, Sorrento, Mud Islands.

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PLATE I.

[*Photo.*: H. T. Reeves

Fig. 1. *Leptospermum laevigatum* (Coast Tea-tree). Typical old trees and associated shrubs, in thickets near Beaumaris cliffs.

[*Photo.*: Helen Aston, Jan., 1958.

Fig. 2. Zones of salt-marsh vegetation on Mud Island:
Foreground—*Atriplex cinerea* (edge of beach sand).
Centre—*Arthrocnemum arbusculum*.
Middle distance (forming "island")—*Salicornia* spp.

PLATE II.

[Photo.: H. T. Reeves.

Fig. 1. *Disphyma australe* (Rounded Noon-flower) in full bloom on salt-marsh near mouth of Yarra River.

[Photo.: H. T. Reeves.

Fig. 2. *Calocephalus brownii* (Cushion-brush) on sand dunes at Sorrento (*Spinifex hirsutus* at extreme right, *Helichrysum paralium* in background).

PORT PHILLIP SURVEY 1957–1963.

ALGAE.

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SUMMARY.

Identifications are given of some 172 species of marine algae collected during the Port Phillip Survey, together with their distribution within the Bay. The great majority occur only in the rough water conditions of Port Phillip Heads and just within, but certain species are largely confined to the very calm Corio Bay and south-western part of the Bay, while others are not found within this area.

INTRODUCTION.

The marine algae of the Port Phillip region are known mainly from early collections by W. H. Harvey, F. von Mueller and others, and particularly from the extensive collections of J. B. Wilson (1892) made (largely by dredging) over several years, near Port Phillip Heads.

The algae collected by the Port Phillip Survey 1957–63 resulted from both diving and dredging, and cover essentially the areas distinctly below low-tide level. Intertidal and just subtidal algae are included only incidentally in this list. Minute epiphytic algae are also omitted. The vast area of the Bay precludes a detailed account of the distribution of many species, particularly the less common ones. Hence the apparent absence of a species from most of the Bay must be viewed with caution if the species is known from well within the Bay. Nevertheless certain species are characteristic of regions within the Bay and these will be discussed briefly below.

For convenience in recording or discussing the species distribution, the Bay has been divided into the following regions (see Charts 1 and 2 back of volume).

Northern bay	..	areas 1–14.
Corio Bay	..	areas 15–18, 25–30, 37–40.
South-western bay	..	areas 42, 49, 50.
Central bay	..	areas 19–22, 31–34, 43–46, 51–54.
Eastern bay	..	areas 23–24, 35–36, 47–48, 55.
Southern bay	..	areas 60–64, 67–70.
Port Phillip Heads	..	areas 58, 59.
Outside bay	..	areas 56–57, 65–66.

The distribution for each species is given according to the above regions of the bay, followed by the area number with the station number in brackets. The data for these collection localities is given in the Table A (back of volume). Only records resulting from the Survey are given below, and no drift specimens are included.

References to each species indicate where either a description of the species can be found or to further literature giving this.

Collections were usually made in duplicate. The first set is now deposited in the Algal Herbarium of the Department of Botany, University of Adelaide, and the second set in the Melbourne National Herbarium.

NOTES ON THE DISTRIBUTION OF MARINE ALGAE WITHIN PORT PHILLIP.

The vast majority of the species collected are confined to the Port Phillip Heads region, where they are subject to strong wave action and currents, with clean water. Within the Bay conditions are not nearly so suitable for marine algae, due to the loose bottom and lack of firm substrata. The relatively shallow water, more variable and often higher temperatures than outside the Bay, more suspended matter, and considerable pollution from shipping and from the city of Melbourne are all factors reducing the number of algae which grow within the Bay.

The only exception amongst the marine algae to their need for a solid substratum is the green alga *Caulerpa*, several species of which grow well on a muddy-sandy area due to their basal surculi or rhizome-like parts. *C. remotifolia* is found in most parts of the Bay, and *C. geminata* and *C. longifolia* f. *crispata* occur mainly in the very calm Corio Bay and along the western coast of the Bay. These species may cover areas many square meters in extent as a virtually closed community. Often however they occur mixed with the marine angiosperm *Zostera*.

The following lists give some idea of the better defined algal distributions within the Bay, based on the Survey records.

Fairly general within the Bay.

Ulva lactuca, Caulerpa remotifolia, probably *Codium harveyi* and *Cutleria multifida, Solieria robusta, Griffithsia teges, Wrangelia protensa, Polysiphonia cancellata, Dictymenia harveyana* and *Laurencia filiformis*.

Largerly restricted to Corio Bay, the calm western coast, and in some cases the Northern bay.

Caulerpa geminata, C. longifolia f. *crispata, Acetabularia peniculus, Dictyota dichotoma, Caulocystis uvifera, Rhabdonia coccinea, Rhodoglossum foliiferum, Botryocladia obovata, Lophothalia verticillata, Jeannerettia pedicellata.*

Around the Bay, excluding the Central bay and very calm western areas.

Caulerpa brownii, Dictyopteris muelleri, Ecklonia radiata, Cystophora retroflexa, Sargassum paradoxum, S. verruculosum.

Comparisons between now and past times of the algal distribution within Port Phillip Bay are not possible owing to lack of previous records of the algae collected *in situ*. Nearly all previous collections were of drift material, or of species growing near low-tide level, with the exception of the dredge collections of J. B. Wilson near Port Phillip Heads (Wilson, 1892). Comparison of the present Survey list with that of Wilson show that a very large number of his species were not recollected during the survey. Many of these are probably rare, but drift material from Port Phillip Heads (not included in this list) shows that the algal flora of this region is still very much richer than is indicated by the Survey list. A thorough survey of intertidal and just subtidal algae would also increase this list considerably.

Phylum CHLOROPHYTA.

Order **Ulvales.**

Family ULVACEAE.

Ulva L.

Ulva lactuca L.

Womersley 1956: 353.

Northern bay—area 6 (118). Corio Bay—areas 40 (101), 17 (171-2). Southern bay—area 60 (85).

Ulva lactuca is more widely distributed throughout Port Phillip Bay than the above collections examined by the author. During the Survey it was also observed in all peripheral areas of the bay, but not in the central bay. On rock platforms around the Heads an *Ulva* with a more dissected, ribbon-like and undulating thallus occurs, as shown by a collection from Portsea—area 59 (23). This may prove to be specifically distinct.

ENTEROMORPHA Link.

No specimens of *Enteromorpha* were collected during the Survey, though the genus is common on jetties, rocks and shells in the lower intertidal and upper sublittoral around the shores of the Bay.

Order **Cladophorales.**

Family CLADOPHORACEAE.

Chaetomorpha Kuetzing.

Chaetomorpha darwinii (Hooker) Kuetzing.

Womersley 1956: 365.

Port Phillip Heads—area 58 (150-4). Outside bay—area 56 (295).

Chaetomorpha indica (Kuetz.) Kuetz.

Womersley 1956: 357.

South-western bay—entrance to Swan Bay, area 50 (228).

Cladophora Kuetzing.

Many species of *Cladophora* are notoriously difficult to determine, and in several cases the Port Phillip material was inadequate.

Cladophora bainesii Harvey.

Womersley 1956: 358.

Eastern bay—area 47 (29, 30).

Cladophora fascicularis (Mert.) Kuetzing.

Womersley 1956: 358.

Northern bay—area 7 (St. Kilda Pier).

A fairly robust form of this species, with only slightly fasciculate branch ends.

Cladophora sp.

Northern bay—area 5 (166). Eastern bay—area 55 (147).

Cladophora sp.

Northern bay—area 10 (103).

Cladophora sp.

Corio Bay—area 27 (47).

Order **Siphonales.**

Family Bryopsidaceae.

Bryopsis Lamouroux.

Bryopsis plumosa (Huds.) C. Agardh.

Womersley 1956: 364.

Northern bay—area 10 (103). Probably widespread.

Family Caulerpaceae.

Caulerpa Lamouroux.

Ten species of *Caulerpa* occur within the Port Phillip survey area. *C. brownii, C. geminata, C. longifolia* f. *crispata,* and *C. remotifolia* are prominent ecologically, especially in the Northern bay and Corio Bay. Other species are largely confined to the Heads or just inside, though in some cases recognized forms occur more within the Bay. The distribution of the common species is shown in Chart III (back of volume).

Caulerpa brownii (C. Agardh) Endlicher.

Womersley 1956: 365.

Northern bay—areas 6 (66–7, 137), 9 (178), 10 (15, 105), 14 (95, 116–117). Corio Bay—area 18 (59, 62). Eastern bay—area 23 (3), 55 intertidal). Southern bay—area 63 (18). South-western bay—area 50 (230–1). Port Phillip Heads—area 59 (23, 79, 225).

A common species in the northern, eastern and southern parts of Port Phillip, but not extending into the very calm areas of Corio Bay. Common also on rock platforms outside Port Phillip, in pools at or below low-tide level. The slenderer forms occur in calmer water.

Caulerpa cactoides (Turner) C. Agardh.

Womersley 1956: 365.

South-western bay—area 50 (230–1). Port Phillip Heads—area 58 (150–4).

Caulerpa flexilis Lamouroux.

Womersley 1956: 366.

South-western bay—area 50 (228). Port Phillip Heads—areas 58 (150–4), 59 (36). Outside bay—area 66 (291).

var. *muelleri* (Sonder) Womersley.

Womersley 1956: 367.

Outside bay—areas 56 (295), 58 (293).

Caulerpa geminata Harvey 1854.

[*C. sedoides* (R. Br. ex Turner) C. Agardh.]

Womersley 1956: 369.

Unfortunately *Fucus sedoides* R. Br. ex Turner 1811 (= *Caulerpa*) is predated by both *Fucus sedoides* Goodenough and Woodward 1797 (= *Gastroclonium ovatum* (Huds.) Pap.) and by *Fucus sedoides* Desfontaines 1798 (= *Cystoseira sedoides* (Desf.) C. Ag.). The earliest specific name available for the Australian *Caulerpa* is *C. geminata* Harvey 1854.

Northern bay—areas 9 (62, 178), 11 (190, 192). Corio Bay—areas 16 (142), 17 (170–1), 18 (307), 26 (126, 301), 27 (41, 47, 138, 242), 28 (315), 29 (107), 37 (40), 38 (311), 39 (44, 313). Port Phillip Heads—area 58 (150–4).

C. geminata is a common alga, often in extensive beds, in the Northern bay and Corio Bay, generally in ½ to 2 fathoms, occasionally up to 5 fathoms. *C. geminata* shows several forms from outside Port Phillip Bay to calm localities within the bay. The rough coast form, found outside the Heads, has spherical to shortly ovoid vesicles arranged radially. On both fairly rough and on somewhat calmer coasts the form with distichous, slightly more elongate vesicles appears, while in the calm areas of the Northern bay and Corio Bay the vesicles are distichous, sometimes irregularly separated on the axes, and often 2–2½ times as long as broad. In many specimens of the latter form the vesicles are somewhat constricted ½–⅔ of the way from the base to apex; this may be due to later more active growth of the apical portion of developing vesicles.

Caulerpa longifolia C. Agardh.

Womersley 1956: 367.

Outside bay—area 56 (295).

f. *crispata* (Harv.) Womersley.

Womersley 1956: 368.

Northern bay—areas 5 (56–7), 166, 168, 169), 9 (178), 10 (15), 14 (116–7). Corio Bay—areas 16 (142), 17 (170–3), 18 (59, 62, 307), 27 (138, 284). Central bay—area 19 (304). Port Phillip Heads—area 58 (150–4).

While the typical form of the species occurs outside Port Phillip, within the Bay and its calmer conditions only f. *crispata* occurs. It is largely restricted to the Northern bay and Corio Bay, where it is one of the commonest algae.

Caulerpa obscura Sonder.

Womersley 1956: 358.

Port Phillip Heads—area 59 (23, 36, 79).

This is a rough water species which only just extends inside the Bay.

Caulerpa remotifolia Sonder.

Womersley 1956: 369.

Northern bay—areas 5 (56–7), 9 (62, 178), 10 (15), 11 (190, 192). Corio Bay—areas 17 (173), 27 (41, 284), 40 (101). Central bay—area 19 (304). South-western bay—area 50 (230, 238). Eastern bay—areas 14 (5), 47 (30).

C. remotifolia only occurs in calm, sheltered waters and is particularly plentiful in the Northern bay and Corio Bay. Most of the specimens are fairly densely pinnate for this species.

Caulerpa scalpelliformis (R. Br. ex Turner) C. Agardh.

Womersley 1956: 369.

Port Phillip Heads—area 59 (36, 79).

This species is confined to the Heads and outer rough coasts.

Caulerpa simpliciuscula (Turner) C. Agardh.

Womersley 1956: 370.

Northern bay—areas 9 (178), 11 (190, 192). Port Phillip Heads—areas 58 (150–4), 59 (23).

Specimens from near and outside the Heads are typical of the species, those from the Northern bay tend to var. *laxa*.

var. *laxa*.

Womersley 1956: 370.

Northern bay—area 6 (118).

Caulerpa trifaria Harvey.

Womersley 1956: 371.

Port Phillip Heads—areas 58 (150–4), 59 (36, 225, 226). Southern bay—area 60 (85).

Family CODIACEAE.

Codium Stackhouse.

Codium duthiae Silva.

Silva and Womersley 1956: 275.

Port Phillip Heads—area 59 (36, 79).

Codium fragile (Sur.) Hariot. s. sp. *novae-zelandiae* (J. Ag.) Silva.

Silva and Womersley 1956: 285.

Northern bay—area 6 (118). Eastern bay—area 48 (32).

This is more usually a rough water species and is probably of odd occurrence only in Port Phillip Bay.

Codium galeatum J. Agardh.

Silva and Womersley 1956: 273.

Port Phillip Heads—area 59 (36, 79).

Another rough water species, confined to the Heads region.

Codium harveyi Silva.

Silva and Womersley 1956: 277.

Corio Bay—areas 16 (143), 27 (41, 138). Eastern bay—areas 14 (95), 55 (22). Southern bay—area 61 (37).

This is typically a calm water species.

Codium perrinae Lucas.

Silva and Womersley 1956: 267.

Eastern bay—area 55 (148).

Order **Dasycladales.**

Family DASYCLADACEAE.

Acetabularia Lamouroux.

Acetabularia peniculus (R. Br. ex Turner) Solms–Lauback.

Womersley 1956: 378.

South-western bay—area 49 (238).

This record is from the very sheltered Swan Bay.

Phylum PHAEOPHYTA.

Order **Ectocarpales.**

Family ECTOCARPACEAE.

Ectocarpus Lyngbye.

Ectocarpus confervoides (Roth) Le Jolis. May 1939.

Southern bay—area 60 (268).

Probably widespread within the bay, on rock and on other algae.

Feldmannia Hamel.

Feldmannia globifer (Kuetzing) Hamel.

Cardinal 1964: 57.

Southern bay—area 60 (268).

Epiphytic and probably more widespread.

Order **Sphacelariales.**

Family SPHACELARIACEAE.

Sphacelaria C. Agardh.

Sphacelaria furcigera Kuetzing.

Sauvageau 1914: 145.

Southern bay—area 60 (268).

Probably widespread.

Halopteris Kuetzing.

Halopteris funicularis (Mont.) Sauvageau.

Sauvageau 1914: 393.

Port Phillip Heads—area 59 (36, 234). Outside bay—area 56 (295).

Halopteris funicularis (Mont.) Sauvageau.

Sauvageau 1914: 416.

Port Phillip Heads—area 59 (36).

Both species of *Halopteris* are rough water alga confined to the Heads or outside.

Cladostephus C. Agardh.

Cladostephus verticillatus (Lightfoot) C. Agardh.

Sauvageau 1914: 488.

Southern bay—area 63 (17–19, 21). Port Phillip Heads—area 59 (36, 234). Outside bay—area 56 (295).

Order **Cutleriales.**

Family CUTLERIACEAE.

Cutleria Greville.

Cutleria multifida (Smith) Greville.

Womersley 1950: 150.

Northern bay—area 5 (166). Central bay—area 43 (303). Eastern bay—area 55 (39).

These few collections propably indicate that *Cutleria* occurs as scattered plants throughout the bay except in very calm areas or near the Heads.

Order **Dictyotales.**

Family DICTYOTACEAE.

Dictyoteae.

Dictyota Lamouroux.

The species of *Dictyota* are notoriously difficult to separate. Except for *D. dichotoma* the following species are represented by a single collection, but the specimens agree well with the type material.

Dictyota alternifida J. Agardh.

J. Agardh 1894: 80.

Northern bay—area 5 (52).

Dictyota apiculata J. Agardh.

J. Agardh 1894: 67; Womersley 1950: 150.

Corio Bay—area 17 (170–1).

Dictyota dichotoma (Huds). Lamx.

Lucas 1936: 91; Womersley 1950: 150.

Northern bay—areas 6 (118, 137), 7 (205). Corio Bay—areas 17 (172), 27 (49).

Dictyota furcellata (C. Ag.) J. Ag.

Womersley 1950: 150.

South-western bay—area 50 (229).

Dictyota sp.

Port Phillip Heads—area 59 (226).

Pachydictyon J. Agardh.

Pachydictyon furcellatum (Harv.) J. Ag.

Lucas 1936: 92.

Port Philip Heads—area 59 (87).

Pachydictyon paniculatum J. Ag.

Lucas 1936: 92; Womersley 1950: 152.

Port Phillip Heads—area 59 (79, 214).

Dilophus J. Agardh.

Dilophus fastigiatus (Sonder) J. Agardh.

Lucas 1936: 93; Womersley 1950: 152.

Outside bay—area 56 (295).

Dilophus sp.

Port Phillip Heads—area 59 (214).

The form of this single collection is similar to *D. foliosus* J. Ag. but broader and more robust. The thallus shows two medullary cells in young parts, four in older parts, and is uniform across the thallus with narrower edges. *D. foliosus* shows thicker edges, with more medullary cells than in the central region.

Lobospira Areschoug.

Lobospira bicuspidata Areschoug.

Lucas 1936: 93; Womersley 1950: 153.

Corio Bay—area 26 (300–1). South-western bay—area 50 (229). Port Phillip Heads—areas 58 (150–4), 59 (36).

Zonarieae.

Dictyopteris Lamouroux.

Dictyopteris muelleri (Sonder) Reinbold.

Womersley 1950: 153.

Northern bay—area 13 (92). Eastern bay—area 55 (35). South-western bay—area 50 (230–1). Port Phillip Heads—area 59 (79, 87, 226).

Probably fairly common except in very calm areas.

Distromium Levring.

Distromium ?

Eastern bay—area 55 (149).

Sterile material.

Padina Adanson.

Padina fraseri (Grev.) J. Ag.

Lucas 1936: 88.

Port Phillip Heads—area 59 (79).

This is a fairly rough water species.

Taonia J. Agardh.

Taonia australasica J. Agardh.

J. Agardh 1894: 30.

Corio Bay—areas 26 (126, 301), 39 (313).

This little know species appears to be confined to very calm areas. Unfortunately all specimens are sterile, so this determination is provisional.

Zonaria C. Agardh.

Zonaria turneriana J. Agardh.

Lucas 1936: 86.

Northern bay—area 13 (93). Corio Bay—area 30 (280). Eastern bay—areas 23 (2), 55 (35, 148–9). Southern bay—areas 61 (37), 64 (164). Port Phillip Heads—area 59 (23, 36, 79).

This is a common species under rough conditions at and outside the Heads and on the Eastern side of the bay.

Zonaria sinclairii H. and H.?

Port Phillip Heads—areas 58 (293), 59 (36).

Juvenile, sterile specimens only.

Order **Sporochnales.**

Family SPOROCHNACEAE.

Bellotia Harvey.

Bellotia eriophorum Harvey.

Lucas 1936: 97.

Port Phillip Heads—area 59 (36, 226).

Carpomitra Kuetzing.

Carpomitra costata (Stackh.) Batters.

Lindauer, Chapman and Aiken 1961: 245.

Carpomitra costata (Stackh.) Batters.

Lindauer, Chapman and Aiken 1961 : 245.

Port Phillip Heads—area 59 (36).

Order **Dictyosiphonales.**

Family Punctariaceae.

Colpomenia Derbes and Solier.

Colpomenia sinuosa (Roth) Derb. and Sol.

Lindauer, Chapman and Aiken 1961: 261.

Port Phillip Heads—area 59 (36).

Probably more widespread within Port Phillip Bay.

Order **Laminariales.**

Family Alariaceae.

Ecklonia Hornemann.

Ecklonia radiata (C.Ag.) J. Ag.

Lucas 1936: 95.

Northern bay—areas 5 (52), 6 (67), 13 (92). Eastern bay—areas 14 (4), 23 (3, 7), 55 (35). Southern bay—area 61 (37). Port Phillip Heads—area 59 (79).

Common on any solid substratum within the bay, except in the calmest areas.

Family Lessoniaceae.

Macrocystis C. Agardh.

Macrocystis angustifolia Bory.

Womersley 1954: 119.

Northern bay—area 10 (103).

Otherwise common in the sublittoral around and outside Port Phillip Heads.

Order **Fucales.**

Family Durvilleaceae.

Durvillea Bory.

Durvillea potatorum (Lab.) Areschoug.

[*Sarcophycus potatorum* (Lab.) Kuetz.]

Lucas 1936: 82.

A dominant alga in the upper sublittoral outside and at the Heads.

Family *Fucaceae.*

Xiphophora Montagne.

Xiphophora chondrophylla (R.Br.) Mont.

Lindauer, Chapman and Aiken 1961: 287.

Port Phillip Heads—area 58 (150–4).

Family SEIROCOCCACEAE.

Seirococcus Greville.

Seirococcus axillaris (R.Br.) Grev.

Lucas 1936: 68.

South-western bay—area 42 (265). Port Phillip Heads—area 58 (150–4).

This is a rough coast species restricted to outside or near the Heads.

Family CYSTOSEIRACEAE.

Acrocarpia Areschoug.

Acrocarpia paniculata (Turner) Areschoug.

Womersley 1964: 98.

Port Phillip Heads—areas 58 (293), 59 (36). Outside bay—area 56 (295).

A rough coast species confined to the Heads.

Caulocystis Areschoug.

Caulocystis cephalornithos (Labill.) Areschoug.

Womersley 1964: 102.

Eastern bay—area 23 (2).

Caulocystis uvifera (C.Ag.) Areschoug.

Womersley 1964: 101.

Northern bay—area 10 (15). Corio Bay—areas 16 (142–3), 27 (41, 138–9), 28 (140–1), 37 (40), 39 (42–6, 313), 40 (101). South-western bay—areas 42 (265, 281), 50 (230–1, 266). Port Phillip Heads—area 59 (23, 36, 79, 213, 225, 226). Outside bay—area 66 (291) (rough reef form.).

This species is found only on the western side of Port Phillip Bay and outside the bay. In the Corio bay area it is found in its typical form but tends to be more robust with slightly ovoid vesicles from the rougher Port Phillip Heads area. Only one specimen definitely referable to *C. cephalornithos* was collected, on the eastern side of Port Phillip Bay.

Cystophora J. Ag.

Most species of *Cystophora* occur at the Heads or just within the bay (e.g., in the south-western bay area). However *C. retroflexa* occurs around most of the bay except in the very calm Corio Bay and the Central Bay.

Cystophora congesta Womersley and Nizamuddin.

Womersley 1964: 86.

South-western bay—area 50 (228). Port Phillip Heads—area 58 (150–4).

Cystophora expansa (Areschoug) Womersley.

Womersley 1964: 77.

Port Phillip Heads—area 59 (79).

Cystophora grevillei (C. Ag. ex. Sonder) J. Ag.

Womersley 1964: 83.

Port Phillip Heads—area 59 (226).

Cystophora monilifera J. Agardh.

Womersley 1964: 75.

Southern bay—area 60 (85). Port Phillip Heads—area 59 (36).

Cystophora moniliformis (Esper) Womersley and Nizamuddin.

Womersley 1964: 71.

Eastern bay—area 55 (35). Southern bay—area 63 (164). Port Phillip Heads—areas 58 (150–4), 59 (23).

Cystophora retorta (Mertens) J. Ag.

Womersley 1964: 92.

Southern bay—area 63 (20).

Cystophora retroflexa (Labill.) J. Ag.

Womersley 1964: 89.

Northern bay—area 14 (95). Eastern bay—area 55 (148). South-western bay—area 42 (281). Southern bay—area 61 (37).

Occurring as scattered plants throughout rougher parts of the bay on suitable firm substrata.

Cystophora siliquosa J. Ag.

Womersley 1964: 93.

South-western bay—area 50 (230–1). Port Phillip Heads—areas 58 (150–4), 59 (23, 79).

Confined to rough conditions outside and just inside the Heads.

Cystophora subfarcinata (Mertens) J. Ag.

Womersley 1964: 95.

South-western bay—area 42 (38). Port Phillip Heads—area 59 (23).

Cystophora torulosa (R.Br. ex Turn.) J. Ag.

Womersley 1964: 85.

South-western bay—area 50 (230–1).

Myriodesma Decaisne.

Myriodesma integrifolia Harvey.

Lucas 1936: 79.

Central bay—area 31 (10). Eastern bay—area 47 (30). Port Phillip Heads—area 59 (87).

Family SARGASSACEAE.

Sargassum C. Agardh.

Many collections of *Sargassum* comprise only the basal leaves or sterile plants, which are quite inadequate for determination. The following species are represented by adequate specimens, but others probably occur in the bay, including species of *Eusargassum*. These sterile *Sargassum* specimens were collected from almost all parts of the Bay.

Sargassum decipiens (R. Br. ex Turner) J. Agardh.

Womersley 1954: 348.

South-western bay—area 42 (108–9). Port Phillip Heads—areas 58 (150–4), 59 (79).

Sargassum heteromorphum J. Agardh.

Womersley 1954: 345.

South-western bay—area 42 (108–9).

Sargassum paradoxum (R. Br.) Hooker and Harvey.

J. Agardh 1889: 69, pl. 20 (II).

Northern bay—area 6 (118). Eastern bay—area 55 (39). Southern bay—area 63 (163). Port Phillip Heads—area 59 (79).

Sargassum sonderi (J. Ag.) J. Agardh.

Womersley 1954: 346.

Port Phillip Heads—area 59 (79).

Sargassum verruculosum (Mertens) C. Agardh.

Womersley 1954: 350.

Northern bay—area 5 (51). South-western bay—area 42 (108, 265). Southern bay—area 63 (21). Port Phillip Heads—area 59 (23, 36, 224, 226).

Phylum RHODOPHYTA.

Order **Nemalionales.**

Family HELMINTHOCLADIACEAE.

Liagora Lamouroux.

Liagora harveyiana Zeh.

Lucas and Perrin 1947: 134.

South-western bay—area 50 (229).

Family BONNEMAISONIACEAE.

Delisea Lamouroux.

Delisea elegans (Ag.) Montagne.

Lucas and Perrin 1947: 240.

Southern bay—area 59 (214).

Order **Gelidiales.**

Family GELIDIACEAE.

Gelidium Lamouroux.

Gelidium australe J. Agardh.

Lucas and Perrin 1947: 143.

Port Phillip Heads—area 58 (150–4).

Gelidium glandulaefolium H. & H.

Lucas and Perrin 1947: 143.

Outside bay—area 66 (291).

Pterocladia J. Agardh.

Pterocladia capillacea (Gmel.) Bornet and Thuret.

Womersley 1950: 165.

Port Phillip Heads—area 59 (36) .

Pterocladia lucida (R. Br.) J. Ag.

Lucas and Perrin 1947: 144.

Port Phillip Heads—areas 58 (293), 59 (36). Outside bay—area 66 (291).

Order **Cryptonemiales.**

Family DUMONTIACEAE.

Dasyphloea Montagne.

Dasyphloea insignis Montagne.

[*D. tasmanica* Harvey].

Lucas and Perrin 1947: 384.

South-western bay—area 50 (229). Port Phillip Heads—area 59 (226).

Family CORALLINACEAE.

Cheilosporum Areschoug.

Cheilosporum elegans (H. & H.) Aresch.

C. sagittatum (Lamx.) Aresch.

Lucas and Perrin 1947: 396.

Port Phillip Heads—area 58 (150–4). Outside bay—area 66 (291).

Corallina L.

Corallina cuvieri Lamx.

Lucas and Perrin 1947: 399.

Southern bay—area 61 (37). Port Phillip Heads—area 59 (23, 36, 79). Outside bay—areas 56 (295), 66 (291).

Corallina officinalis L.

Womersley 1950: 167.

Northern bay—areas 5 (54), 6 (118). Outside bay—area 56 (295).

Jania Lamouroux.

Jania fastigiata Harvey.

Lucas and Perrin 1947: 397.

Port Phillip Heads—area 58 (150–4).

Metagoniolithon W. v. Bosse.

Metagoniolithon stelligerum (Lamk.) W. v. Bosse.

Lucas and Perrin 1947: 394.

Port Phillip Heads—area 59 (79, 234).

Family GRATELOUPIACEAE.

Grateloupia C. Agardh.

Grateloupia filicina var. *luxurians* A. & E. S. Gepp.

Lucas and Perrin 1947: 377.

Northern bay—area 6 (118).

Polyopes J. Agardh.

Polyopes constrictus (Turn.) J. Ag.

Lucas and Perrin 1947: 379.

Port Phillip Heads—area 59 (36).

Family KALLYMENIACEAE.

Callophyllis Kuetzing.

Callophyllis ceratoclada (J. Ag.) Womersley.

Eastern bay—area 23 (3, 9).

Callophyllis harveyana J. Agardh.

Lucas and Perrin 1947: 158.

Port Phillip Heads—area 59 (226).

Order **Gigartinales.**

Family Gracilariaceae.

Gracilaria Greville.

Gracilaria confervoides (L.) Grev.

Lucas and Perrin 1947: 188. May 1948: 18.

Central bay—area 51 (270). Eastern bay—area 55 (35).

Gracilaria furcellata Harvey.

May 1948: 53.

South-western bay—area 42 (38, 281). Southern bay—area 60 (85, 235).

Gracilaria secundata Harvey.

May 1948: 46.

South-western bay—area 49 (238).

Melanthalia Montagne.

Melanthalia obtusata (Lab.) J. Ag.

Lucas and Perrin 1947: 183.

Port Phillip Heads—areas 58 (293), 59 (36).

Family Plocamiaceae.

Plocamium Lamouroux.

Plocamium angustum (J. Ag.) H. & H.

Lucas and Perrin 1947: 211.

Southern bay—area 60 (85). Port Phillip Heads—areas 58 (150–4), 59 (36, 79, 224, 226). Outside Heads—area 66 (291).

Plocamium coccineum (Huds.) Lyngbye.

Newton 1931: 443.

Port Phillip Heads—area 59 (36).

Plocamium costatum (J. Ag.) H. & H.

Lucas and Perrin 1947: 212.

Port Phillip Heads—area 59 (36, 79). Outside bay—area 56 (295).

Plocamium mertensii (Grev.) Harvey.

Lucas and Perrin 1947: 215.

South-western bay—area 50 (229).

Plocamium preissianum Sonder.

Lucas and Perrin 1947: 211.

Outside bay—area 66 (291).

Family Sphaerococcaceae.

Phacelocarpus Endl. and Diesing.

Phacelocarpus labillardieri (Mert.) J. Agardh.

Lucas and Perrin 1947: 181.

Port Phillip Heads—area 59 (87). Outside bay—area 56 (295).

Family SARCODIACEAE.

Nizymenia Sonder.

Nizymenia australis Sonder.

Lucas and Perrin 1947: 182.

Outside bay—areas 57 (294), 66 (291).

Family SOLIERIACEAE.

Solieria J. Agardh.

Solieria mollis Harvey.

Harvey 1863, synop: 41.

Port Phillip Heads—area 59 (36).

Solieria robusta (Grev.) Kylin.

Lucas and Perrin 1947: 174.

Northern bay—areas 5 (54, 58), 9 (178), 11 (191), 13 (93). Corio Bay—areas 16 (142–3), 27 (41, 138–9), 28 (140–1). Eastern bay—areas 14 (4), 23 (3, 9). South-western bay—area 42 (38, 265, 281). Port Phillip Heads—area 59 (87, 226).

Family RHABDONIACEAE.

Areschougia Harvey.

Areschougia laurencia (H. & H.) Harvey.

Lucas and Perrin 1947: 174.

Corio Bay—area 30 (280). South-western bay—area 42 (38, 265).

Erythroclonium Sonder.

Erythroclonium muelleri Sonder.

Lucas and Perrin 1947: 170.

Port Phillip Heads—area 58 (150–4).

Rhabdonia Harvey.

Rhabdonia coccinea Harvey.

Lucas and Perrin 1947: 171.

Northern bay—areas 6 (118), 10 (103–4), 14 (117). Corio bay—areas 16 (142–3), 17 (170–1), 27 (138–9), 28 (140–1).

Rhabdonia nigrescens Harvey.

Lucas and Perrin 1947: 171.

Port Phillip Heads—area 59 (36).

Rhabdonia verticillata Harvey.

Lucas and Perrin 1947: 172.

South-western bay—areas 42 (281), 50 (230–1). Port Phillip Heads—area 59 (79).

Family RHODOPHYLLIDACEAE.

Rhodophyllis Kuetzing.

Rhodophyllis goodwiniae J. Agardh.

Lucas and Perrin 1947: 167.

Southern bay—area 59 (87, 214). Outside bay—area 66 (291).

Family HYPNEACEAE.

Hypnea Lamouroux.

Hypnea episcopalis H. & H.

Lucas and Perrin 1947: 191.
Eastern bay—areas 14 (4, 9), 23 (3).

Hypnea sp.

Corio Bay—area 27 (41). South-western bay—area 42 (38).

Family MYCHODEACEAE.

Ectoclinium J. Agardh.

Ectoclinium dentatum J. Agardh.

Kylin 1932: 65.
Outside bay—area 57 (295).

Mychodea Harvey.

Mychodea compressa Harvey.

Lucas and Perrin 1947: 156.
Port Phillip Heads—area 59 (79).

Mychodea foliosa (Harv.) J. Agardh.

Lucas and Perrin 1947: 156.
Port Phillip Heads—area 58 (150–4).

Mychodea hamata Harvey.

Lucas and Perrin 1947: 156.
Port Phillip Heads—area 58 (150–4).

Mychodea membranacea Harvey?

Lucas and Perrin 1947: 156.
Eastern bay—area 47 (29).

Family DICRANEMACEAE.

Dicranema Sonder.

Dicranema grevillei Sonder.

Lucas and Perrin 1947: 157.
Southern bay—area 59 (214).

Family PHYLLOPHORACEAE.

Stenogramme Harvey.

Stenogramme leptophylla J. Agardh.

Lucas and Perrin 1947: 154.
Port Phillip Heads—area 59 (87).

Family GIGARTINACEAE.

Gigartina Stackhouse.

Gigartina brachiata Harvey.

Womersley 1950: 174.
Northern bay—area 6 (118). Corio Bay—area 16 (284).

Gigartina muelleriana Setchell and Gardner.

Lucas and Perrin 1947: 149.

Port Phillip Heads—area 58 (150–4).

Rhodoglossum J. Agardh.

Rhodoglossum foliiferum (Harvey) J. Agardh.

[*Iridaea foliifera* Harvey.]

Harvey 1860: 326.

Northern bay—areas 5 (56), 6 (118), 9 (178). Corio Bay—areas 15 (284), 17 (170–1). Southern bay—area 60 (235).

Rhodoglossum proliferum J. Agardh.

Womersley 1950: 174.

Northern bay—area 5 (56, 167).

Order **Rhodymeniales.**

Family RHODYMENIACEAE.

Botryocladia Kylin.

Botryocladia obovata (Sonder) Kylin.

[*Chrysymenia obovata* Sonder.]

Lucas and Perrin 1947: 203.

Northern bay—areas 5 (165), 9 (178), 10 (15, 103–6), 11 (190–1). Corio Bay—areas 18 (60–61, 307–8), 27 (41). Southern bay—areas 63 (249), 68 (218), 69 (99).

Erythrymenia Schmitz.

Erythrymenia minuta Kylin.

Kylin 1931: 13.

Outside bay—area 66 (291).

Gloiosaccion Harvey.

Gloiosaccion brownii Harvey.

Lucas and Perrin 1947: 202.

Corio Bay—area 30 (280). South-western bay—area 42 (265).

Rhodymenia Greville.

Rhodymenia australis Sonder.

Lucas and Perrin 1947: 200.

Northern bay—area 6 (137). South-western bay—area 42 (109). Port Phillip Heads—area 59 (87).

Family CHAMPIACEAE.

Champia.

Champia affinis var. *arcuata* H. & H.

Lucas and Perrin 1947: 206.

Port Phillip Heads—area 59 (234).

Champia obsoleta Harvey.

Lucas and Perrin 1947: 206.

Port Phillip Heads—area 59 (36).

Champia tasmanica Harvey.

Lucas and Perrin 1947: 207.

Port Phillip Heads—area 59 (36, 87). Outside bay—area 66 (291).

Order **Ceramiales.**

Family CERAMIACEAE.

Antithamnion Naegeli.

Antithamnion mucronatum (J. Ag.) Naegeli.

Lucas and Perrin 1947: 355.

Southern bay—area 60 (85).

Ballia Harvey.

Ballia callitricha (Ag.) Montagne.

Lucas and Perrin 1947: 350.

Port Phillip Heads—area 58 (293). Outside bay—area 66 (291).

Ballia scoparia (H. & H.) Harvey.

Lucas and Perrin 1947: 351.

Outside bay—area 56 (295).

Ceramium Roth.

As well as the three unidentified species listed below, fragments of *Ceramium* are common on larger algae.

Ceramium sp.

Corio Bay—area 17 (170–6). Eastern bay—area 55 (148).

Ceramium sp.

Corio Bay—area 27 (41).

Ceramium sp.

Northern bay—areas 3 (202), 7 (205).

Griffithsia C. Agardh.

Griffithsia teges Harvey.

Harvey 1854: 559.

Northern bay—area 6 (118), 13 (92–3). Corio Bay—area 30 (280). Eastern bay—area 47 (30). Port Phillip Heads—area 59 (23).

Neomonospora Setchell and Gardner.

Neomonospora griffithsioides (Sonder) Womersley.

Womersley 1950: 177.

Northern bay—area 6 (64, 67, 118). South-western bay—area 42 (108). Port Phillip Heads—area 59 (36).

Spongoclonium Sonder.

Spongoclonium conspicuum Sonder.

Harvey 1860: 355.

Port Phillip Heads—area 59 (226).

Spyridia Harvey.

Spyridia opposita Harvey.

Lucas and Perrin 1947: 363.

Port Phillip Heads—area 59 (36).

Wrangelia C. Agardh.

Wrangelia protensa Harvey.

Lucas and Perrin 1947: 137.

Northern bay—areas 6 (63), 14 (117). Corio Bay—area 17 (170–1). Eastern bay—area 47 (29). Southern bay—area 63 (16–21).

Family DASYACEAE.

Dasya C. Agardh.

Dasya naccarioides Harvey.

Lucas and Perrin 1947: 313.

Southern bay—area 60 (269). Port Phillip Heads—area 59 (23, 79).

Dasya villosa Harvey.

Lucas and Perrin 1947: 314.

Northern bay—area 14, (4, 5). Eastern bay—areas 23 (3), 55 (22). Corio Bay—area 37 (40).

Heterosiphonia Montagne.

Heterosiphonia gunniana (Harv.) Falk.

Lucas and Perrin 1947: 316.

Corio Bay—area 17 (170–1).

Heterosiphonia muelleri (Sond.) De Toni.

Lucas and Perrin 1947: 319.

South-western bay—area 50 (230–1). Port Phillip Heads—area 59 (226).

Family DELESSERIACEAE.

Acrosorium Zanardini.

Acrosorium uncinatum (J. Ag.) Kylin.

Lucas and Perrin 1947: 223.

Northern bay—area 6 (137). Corio Bay—area 17 (170–1).

Hymenena Greville.

Hymenena affinis (Harv.) Kylin.

Lucas and Perrin 1947: 223.

Port Phillip Heads—area 59 (234).

Myriogramme Kylin.

Myriogramme gunniana (Harv.) Kylin.

Lucas and Perrin 1947: 218.

Southern bay—area 60 (85). Port Phillip Heads—area 59 (234).

Myriogramme sp.

Outside heads—area 66 (291).

Nitophyllum Greville.

Nitophyllum parvifolium J. Agardh?

J. Agardh 1876: 457.

Port Phillip Heads—area 58 (150–4).

Nitophyllum sp.

Northern bay—area 6 (118). Corio Bay—area 17 (170–2).

Phitymophora J. Agardh.

Phitymophora imbricata (Areschoug) J. Agardh.

Lucas and Perrin 1947: 230.

Port Phillip Heads—area 59 (79).

Family RHODOMELACEAE.

Sarcomenieae.

Malaconema Womersley and Shepley.

Malaconema roeana (Harvey) Womersley and Shepley.

Womersley and Shepley 1959: 204, 210.

Corio Bay—area 29 (107). South-western bay—area 42 (108, 109).

Sarcotrichia Womersley and Shepley.

Sarcotrichia dolichocystidea (J. Ag.) Womersley and Shepley.

Womersley and Shepley 1959: 192, 209–210.

Corio Bay—areas 18 (60–1), 26 (301), 29 (107).

Polysiphonieae.

Lophurella Schmitz.

Lophurella pericIados (Sond.) Schmitz.

Lucas and Perrin 1947: 261.

Northern bay—areas 6 (118), 10 (103), 13 (93). Corio Bay—area 29 (107). South-western bay—area 42 (109).

Polysiphonia Greville.

As well as the following two species, others occur within the bay but collections made were not adequate for determination.

Polysiphonia blandi Harvey.

Lucas and Perrin 1947: 269.

South-western bay—area 50 (228).

Polysiphonia cancellata Harvey.

Lucas and Perrin 1947: 273.

Northern bay—area 9 (178). Corio Bay—areas 16 (142–3), 27 (138–9), 28 (140–1), 37 (40), 39 (313). Eastern bay—area 55 (39). South-western bay—areas 42 (281), 50 (266).

Lophothalieae.

Brongniartella Bory.

Brongniartella australis (Ag.) Schmitz.

Lucas and Perrin 1947: 283.

South-western bay—area 42 (108). Eastern bay—area 55 (35). Southern bay—areas 60 (85), 63 (17–19, 21).

Lophothalia Kuetzing.

Lophothalia verticillata (Harvey) Kuetz.

Lucas and Perrin 1947: 285.

Northern bay—area 12 (110). Corio Bay—area 30 (280). South-western bay—area 42 (108–9). Southern bay—area 63 (249).

Lophothalia sp.

Northern bay—areas 10 (15), 14 (4). Corio Bay—area 17 (170–1). Eastern bay—areas 23 (3, 9), 55 (22).

Pterosiphonieae.

Dictymenia Greville.

Dictymenia harveyana Sonder.

Lucas and Perrin 1947: 282.

Corio Bay—areas 28 (140), 30 (280). South-western bay—areas 42 (108–9), 50 (228). Central bay—area 51 (250). Southern bay—area 60 (85) Port Phillip Heads—area 59 (214, 224, 226).

Placophorieae.

Jeannerettia H. & H.

Jeannerettia lobata H. & H.

Lucas and Perrin 1947: 278.

Port Phillip Heads—area 59 (79, 214, 224).

Jeannerettia pedicellata (Harv.) Pap.

Lucas and Perrin 1947: 278.

Corio Bay—areas 15 (284), 30 (280). South-western bay—area 42 (109, 265). Southern bay—area 63 (17–19, 21).

Polyzonieae.

Dasyclonium J. Agardh.

Dasyclonium incisum (J. Ag.) Kylin.

[*Euzoniella incisa* (J. Ag.) Falk.]

Lucas and Perrin 1947: 287.

Port Phillip Heads—area 58 (150–4).—On *Gelidium australe.*

Amansieae.

Lenormandia Sonder.

Lenormandia prolifera (Ag.) J. Ag.

Lucas and Perrin 1947: 302.

Southern bay—area 60 (85). Port Phillip Heads—area 59 (87, 224).

Lenormandia smithiae (H. & H.) Falk.

Lucas and Perrin 1947: 303.

Southern bay—area 60 (85).

Chondrieae.

Cladurus Falkenberg.

Cladurus elatus (Sond.) Falk.

Lucas and Perrin 1947: 251.

Port Phillip Heads—area 58 (150–4).

Coeloclonium J. Agardh.

Coeloclonium opuntioides (Harv.) J. Ag.

Lucas and Perrin 1947: 256.

South-western bay—areas 42 (109, 265), 50 (266). Central bay—area 51 (250).

Laurencieae.

Laurencia Lamouroux.

Laurencia clavata Sonder.

Outside bay—area 66 (291).

Laurencia elata (Ag.) Harvey.

Lucas and Perrin 1947: 249.

Port Phillip Heads—area 58 (293).

Laurencia filiformis (Ag.) Mont.

Lucas and Perrin 1947: 247.

Northern bay—areas 6 (137), 10 (103), 14 (4, 9, 95). Corio Bay—area 27 (41). Eastern bay—areas 23 (3), 47 (30).

Laurencia heteroclada Harvey.

Lucas and Perrin 1947: 247.

Port Phillip Heads—area 59 (36). Outside bay—areas 56 (295), 59 (23).

Laurencia tasmanica H. & H.

Lucas and Perrin 1947: 249.

Southern bay—area 61 (37). Port Phillip Heads—area 59 (23). Possible juvenile forms in Central Bay—areas 43 (303), 51 (250), and Port Phillip Heads—area 59 (79).

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PORT PHILLIP SURVEY 1957–1963.

HYDROIDA.

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SUMMARY.

Athecate hydroids (5 species) and thecate hydroids (28 species) were taken from 23 of the 70 areas sampled. Approximately one-third of the total number of species have not previously been recorded from Port Phillip. The thecate family Sertulariidae is represented by the greatest number of species namely thirteen, and areas 58 and 59 are particularly rich in hydroids both in respect to numbers of species and quantity of material collected.

INTRODUCTION.

During the Port Phillip Bay ecological survey from 1957 to 1963, 33 species of hydroids in all were collected from 23 of the 70 areas sampled. These hydroids were taken either by dredging or skin-diving down to a depth of approximately seven fathoms. Eleven species, *Eudendrium capillare* Alder; *Tubularia* (?) *larynx* Ellis and Solander; *Myriothela australis* Briggs, 1928; *Orthopyxis crenata* (Hartlaub); *Hincksella corrugata* Millard, 1958; *Dynamena quadridentata* (Ellis and Solander); *Symplectoscyphus subdichotomus* (Kirchenpauer); *Symplectoscyphus* sp.; *Sertularella simplex* (Hutton); *Sertularella undulata* Bale and *Aglaophenia decumbens* Bale have not previously been recorded from Port Phillip. Two of these species however, namely *Dynamena quadridentata* and *Symplectoscyphus subdichotomus* have been taken in the adjacent Bass Strait area; *Sertularella undulata* and *Aglaophenia decumbens* from Tasmania and *Myriothela australis* from New South Wales waters. Of the remaining six species, *Eudendrium capillare* and *Tubularia larynx* are cosmopolitan, *Sertularella simplex* and *Orthopyxis crenata* are best known from New Zealand waters, *Symplectoscyphus* sp. is known only from Port Phillip, and *Hincksella corrugata* from the Natal coast of South Africa.

Thecate hydroids are dominant both in number of species taken and in quantity, although large handsize " tufts " of *Tubularia* (?) *larynx* were present in the collections. The family of thecate hydroids represented by the greatest number of species is the Sertulariidae with thirteen species, followed by the Plumulariidae with seven species and the Campanulariidae with five species. The families Haleciidae, Lafoeidae and Syntheciidae are represented by one species each.

Three species only from the family Sertulariidae were taken in the inner-Bay areas, the others were found towards the entrance of the Bay particularly in areas 58 and 59. Collections from these latter areas

together with those from the nearby areas of 60, 61, 62, 63, 66, and 68 showed by far the greatest variety of species. Of the plumularians, only *Plumularia setaceoides* (Areas 30; 31) was not collected in the outer-Bay area. Area 59 (36) Popes Eye Bank and Area 58 seem especially rich in hydroid species as 26 of the 33 species recorded here were taken from these areas. Collection at Point Cook Jetty (Area 10; (103)) during the same time period yielded the next largest number of species, that is five in all. The species most frequently taken over the whole collection range were *Plumularia wattsii*, *Obelia australis* and the small sertularian *Amphisbetia minima*.

LIST OF HYDROID SPECIES TAKEN DURING THE SURVEY OF PORT PHILLIP 1957–1963.

Species previously recorded from Port Phillip are given in bold face type.

ATHECATA	
EUDENDRIIDAE	
Eudendrium capillare Alder, 1857 ..	Areas 10 (103); 59 (36).
TUBULARIIDAE	
TUBULARIA RALPHII Bale, 1884 ..	Areas 14 (117); 58 (–).
Tubularia (?) *larynx* Ellis and Solander 1768	Areas 10 (11); 12 (110–3); 60 (268).
PENNARIIDAE	
PENNARIA DISTICHA Goldfuss, 1820	Areas 58 (80); 61 (37); 62 (221–2).
MYRIOTHELIDAE	
Myriothela australis Briggs, 1928 ..	Area 59 (24).
THECATA	
CAMPANULARIIDAE	
OBELIA AUSTRALIS von Lendenfeld, 1885.	Areas 12 (110–3); 21 (115); 30 (130); 31 (10); 43 (303); 61 (37); 63 (16); 58 (218–9).
OBELIA GENICULATA Linnaeus, 1758 forma *subtropica* Ralph, 1956	Areas 30 (130); 58 (80).
Orthopyxis crenata (Hartlaub, 1901) forma *subtropica* Ralph, 1957.	Areas 42 (108); 58 (79); 59 (36).
ORTHOPYXIS CALICULATA (Hincks, 1863).	Area 59 (87).
SILICULARIA BILABIATA (Coughtrey, 1875) forma *subtropica* Ralph, 1956.	Areas 5 (54); 10 (103); 59 (36); 61 (204).
HALECIIDAE	
HALECIUM DELICATULUM Coughtrey, 1876.	Area 59 (87).
LAFOEIDAE	
HEBELLA CALCARATA (L. Agassiz, 1862).	Area 59 (36).
SYNTHECIIDAE	
Hincksella corrugata Millard, 1958. ..	Area 59 (36).
SERTULARIIDAE	
THYROSCYPHUS MARGINATUS (Bale, 1884).	Areas 58 (80); 59 (36).

STEREOTHECA ELONGATA (Lamouroux, 1816).	Areas 58 (88); 59 (36).
DIPHASIA SUBCARINATA (Busk, 1852).	Areas 58 (88); 59 (36).
AMPHISBETIA MINIMA (Thompson, 1879).	Areas 5 (54); 29 (107); 58 (79); 59 (24. 87).
AMPHISBETIA OPERCULATA (Linnaeus, 1758).	Area 59 (87).
SERTULARIA UNGUICULATA Busk, 1852.	Area 58 (88).
THUIARIA LATA Bale, 1882	Area 58 (223).
Dynamena quadridentata (Ellis and Solander, 1786).	Area 10 (103).
Symplectoscyphus subdichotomus Kirchenpauer, 1884).	Area 51 (271); 62 (99).
Symplectoscyphus sp.	Area 59 (36).
Sertularella simplex (Hutton, 1873). ..	Areas 43 (303); 58 (79); 59 (36).
SERTULARELLA ROBUSTA Coughtrey, 1876.	Area 10 (103).
Sertularella undulata Bale, 1915. .	Area 59 (36).
PLUMULARIIDAE	
PLUMULARIA SETACEOIDES Bale, 1882.	Areas 30 (130); 31 (10).
PLUMULARIA WATTSII Bale, 1887 ..	Areas 19 (179); 43 (303); 51 (271); 53 (253); 58 (223); 66 (292); 68 (218–9).
PLUMULARIA PROCUMBENS Spencer, 1891.	Area 58 (223).
AGLAOPHENIA DIVARICATA (Busk, 1852).	Areas 58 (223); 59 (36); 66 (292).
Aglaophenia decumbens Bale, 1914. ..	Areas 59 (36); 69 (221–2).
HALICORNARIA LONGIROSTRIS (Kirchenpauer, 1872).	Area 69 (221–2).

A description of the above species with the exception of *Eudendrium capillare, Tubularia ralphii, Myriothela australis, Hincksella corrugata, Thyroscyphus marginatus, Thuiaria lata, Sertularella undulata, Plumularia procumbens, Aglaophenia divaricata*, and *Aglaophenia decumbens* was given by Ralph (1953, 1957, 1958, 1961a, 1961b,). Hodgson (1950) is a reference source for a description of *Sertularella undulata, Aglaophenia divaricata* and *A. decumbens;* Bale (1884) for *Tubularia ralphii* and *Thuiaria lata;* Hincks (1868) for *Eudendrium capillare;* Spencer (1891) for *Plumularia procumbens;* Millard (1958) for *Hincksella corrugata;* Splettstosser (1929) for *Thyroscyphus marginatus*, and Manton (1940) for *Myriothela australis.*

AREA DISTRIBUTION.

Full details of the collecting schedule is given in the introductory paper to the Port Phillip Survey. (cf. Macpherson and Lynch, page 1.)

Positions of Areas and Stations are shown on Charts 1 and 2 (back of volume).

Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171, Port Phillip with the numbered area grid superimposed.

Chart 2 shows position of the stations numbered 1–317 with the same grid superimposed to aid in location of the stations and for correlation with depth, etc.

Localities in the text are shown as Area number followed immediately by the station number in brackets. Table A (back of volume) records station number, date, method of collecting (dive or dredge) and depth in fathoms.

AREA 5 (54).

Amphisbetia minima.
Silicularia bilabiata forma *subtropica.*

AREA 10 (103).

Silicularia bilabiata forma *subtropica.*
Dynamena quadridentata.
Eudendrium capillare.
Orthopyxis crenata forma *subtropica.*
Sertularella robusta.

AREA 10 (11).

Tubularia (?) *larynx*

AREA 12 (110–3).

Tubularia (?) *larynx.*
Obelia australis.

AREA 14 (117).

Tubularia ralphii.

AREA 19 (179).

Plumularia wattsii.

AREA 21 (115)

Obelia australis.

AREA 29 (107).

Amphisbetia minima.

AREA 30 (130).

Obelia geniculata forma *subtropica.*
Plumularia setaceoides.
Obelia australis.

AREA 31 (10).

Plumuiaria setaceoides.
Obelia australis.

AREA 42 (108).

Orthopyxis crenata forma *subtropica.*

AREA 43 (303).

Obelia australis.
Sertularella simplex.
Plumularia wattsii.

AREA 51 (271).

Symplectoscyphus subdichotomus
Plumularia wattsii.

AREA 53 (253).

Plumularia wattsii.

AREA 58 (—).

Tubularia ralphii.
Thyroscyphus marginatus.

AREA 58 (79).

Orthopyxis crenata forma *subtropica.*
Amphisbetia minima.
Sertularia unguiculata.
Sertularella simplex.

AREA 58 (80).

Obelia geniculata forma *subtropica.*
Pennaria disticha.

AREA 58 (88).

Diphasia subcarinata.

AREA 58 (223).

Stereotheca elongata.
Thuiaria lata.
Plumularia wattsii.
Plumularia procumbens.
Aglaophenia divaricata.

AREA 59 (24).

Myriothela australis.

AREA 59 (36).

Amphisbetia minima.
Sertularella simplex.
Aglaophenia divaricata.
Hebella calcarata.
Sertularella undulata.
Stereotheca elongata.
Symplectoscyphus sp.
Aglaophenia decumbens.
Eudendrium capillare.
Silicularia bilabiata forma *subtropica*
Diphasia subcarinata.
Amphisbetia operculata.
Hincksella corrugata.
Thyroscyphus marginatus.

AREA 59 (87).

Orthopyxis caliculata.
Halecium delicatulum.
Amphisbetia minima.
Aglaophenia decumbens.

AREA 60 (268).

Tubularia (?) *larynx.*

AREA 61 (37).

Pennaria disticha.

AREA 61 (240).

Obelia australis.
Silicularia bilabiata forma *subtropica*

AREA 62 (99).

Symplectoscyphus subdichotomus.

AREA 62 (221–2).

Pennaria disticha.
Aglaophenia decumbens.
Halicornaria longirostris.

AREA 63 (16).

Obelia australis.

AREA 66 (292).

Plumularia wattsii.
Aglaophenia divaricata.

AREA 68 (218–9).

Obelia australis.
Plumularia wattsii.

SYSTEMATIC REMARKS ON SOME OF THE SPECIMENS COLLECTED.

Genus *Eudendrium* Ehrenberg, 1834.

A small *Eudendrium* sp. rather similar in erect stem habit to the present specimens was described by Bale from the neighbouring area of Portland in 1884. The Port Phillip specimens have irregularly branched stems up to 1·75 cm. in height and a few possessed male gonophores on the proximal third of the stem. The position and characters of these male gonophores as well as the characters of the erect, monosiphonic stem determine the present specimens as *Eudendrium capillare* Alder, 1857.

Genus *Tubularia* Linnaeus, 1758.

The two tubularians collected were very different in size. The smaller has irregularly corrugated stems averaging in height 4·0 cm. while the larger possesses tall smooth stems about 10·0 cm. in height. The shorter species is tentatively identified as *T. larynx* because of the stem size and the presence of corrugations. When collected the two hand-size clumps of this small tubularian appear to have been in a moribund state and the two or three immature hydranths observed did not allow a firm decision on the status of the material to be made. The tall-stemmed tubularian possesses characters similar to that described by Bale (1884) for specimens from Port Phillip, and by other workers (Broch, 1948) for *T. ralphii* Bale.

Genus *Pennaria* Oken, 1815.

The present specimens possess stem characters similar to those described for *Pennaria disticha* var. *disticha*, in that the pedicel of the hydranth is ringed along its whole length and not just at the proximal and distal ends as in the more common variety taken in Australian and New Zealand waters, namely *P. disticha* var. *australis*. The number of capitate tentacles on the hydranth cannot be accurately determined in the present material. No eyespot at the tentacular base of the attached gonophores was observed in the few fertile polyps available for study.

Genus *Myriothela* Sars, 1849.

Three specimens of the solitary capitate hydroid *Myriothela australis* Briggs, 1928 were taken. They range in length (as preserved) from 2·0 cm. to 3·5 cm. and all possess mature female blastostyles which show the features described and figured by Briggs (1929) and Manton (1940), for *M. australis*.

Genus *Hincksella* Billard, 1925.

Six unattached stems from one locality were collected of the small unbranched synthecid *H. corrugata* Millard, 1958, which also possess distinctive alternating hydrothecae. The maximum height of stem was 5·0 mm. and up to eight hydrothecae were present on a stem. The dimensional range of the hydrotheca, and the stem internodes falls within that given by Millard for her Natal specimens. Also, the faint transverse corrugations described by Millard on the walls of the hydrotheca, the everted margin to the hydrotheca, the presence of basal corrugations on

the stem and the similar ratio of the length of free hydrothecal wall to adnate wall (1 : 1 approx.) are characters easily observed in the present material.

The description of *Hincksella cylindrica* (Bale, 1884) shows this species to be rather similar to *H. corrugata*. However, Millard (1958) clearly distinguishes the two species, and although the present material comes from the same locality as Bale's *H. cylindrica* the present material shows the characters of *H. corrugata* and is here recognized as the latter species.

Genus *Symplectoscyphus* Marktanner-Turneretscher, 1890.

The erect stem characters of one of the two symplectoscyphids taken in Area 59 suggest that it is a new species, but the colonies are infertile and the decision on the specific status of this material must await the collection of fertile specimens. A description of the erect stem characters is as follows.

Symplectoscyphus sp.

(Figs. 1–4).

Erect stem monosiphonic, up to 3·5 cm. in height, stem stiff, usually subdichotomously branched; branches arising from stem at approximately 75°; branch internodes not readily distinguishable from those of the stem except for the proximal internode, which is borne on an apophysis of the stem internode, and is distinctive in that it is approximately twice the length (0·75 mm.) and half the width (0·18 mm.) of other branch internodes (Fig. 1); nodes regular and clearly marked on stem and branches by an oblique twisted constriction which directs the hydrothecae towards the front of the stem; internode swollen immediately above and below the nodal constriction; two hydrothecae of the stem between each subdichotomy and one in the axil of each branch; internodes (other than proximal branch internodes) 0·50 to 0·80 mm. in length and 0·09 to 0·125 mm. in width at the middle; hydrothecae set at an angle of opproximately 40° to stem and branches; adcauline side of hydrotheca from two-thirds to three-quarters of its length from stem and branches; hydrotheca large, with adcauline side, measured from margin to base 0·40 to 0·50 mm. in length, and adcauline side, 0·25 to 0·37 mm. in length; greatest width of hydrotheca, which occurs about half-way up the theca, is from 0·20 mm. to 0·25 mm.; width at margin of hydrotheca approximately 0·14 mm. hydrotheca flattened on three sides, so that it is subtriangular in cross section, the "angles" of the triangle corresponding approximately in position to the marginal teeth (Fig. 4); edge and sides of hydrotheca facing toward stem or branches with, in most cases, three well formed ridges; adcauline edge without ridges and straight in outline from margin to base of hydrotheca; adcauline edges bulging towards the stem or branch, at the base of the hydrotheca (Fig. 3); margin of hydrotheca with three very well developed, thick, robust, bluntly pointed teeth, the outermost tooth being the largest, and the inner median adcauline tooth the smallest; three deep embayments between the teeth; margin of hydrotheca greatly thickened down to the level of the origin of the three components of the operculum, at which level the thickening ceases abruptly; three large, internal submarginal teeth present (Fig. 2).

FIG. 1. *Symplectoscyphus* sp. Portion of erect stem to show growth habit (branches of left side detached from stem).

FIG. 2. Aperture and marginal region of hydrotheca showing operculum and one internal submarginal tooth.

FIGS. 3–4. Hydrothecae from different aspects.

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PORT PHILLIP SURVEY 1957–1963.

SCLERACTINIA.

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SUMMARY.

In contrast to the Great Barrier Reef, the corals of southern and western Australia are poorly known. The present paper reviews the brief literature and discusses known distribution. In the discussion hermatypic corals occurring from Port Jackson south to Bass Strait and westward to Cape Leeuwin are considered and the ahermatypic corals recorded as occurring in Port Phillip are listed.

INTRODUCTION.

At the kind invitation of Miss J. Hope Macpherson, I examined the corals collected in the course of the ecological survey of Port Phillip, Victoria, Australia. Because the littoral coral fauna of the southern coast of Australia is poorly known, the specimens are of especial interest. Over 75 years ago, the Reverend J. E. Tenison–Woods (1878, p. 292) remarked "I may say that the extratropical *Madreporaria* of Australia have been literally untouched". This statement applies as well to-day to our knowledge of the corals of the southern and western coasts, in distinct contrast to that resulting from the increasing number of studies of the Scleractinia of the Great Barrier Reef.

Wells (1955a) has reviewed the distribution of the hermatypic (reefforming) corals of the Great Barrier Reef. He demonstrated that the vast coral fauna of this reef diminishes from a total of 60 genera (approximately 350 species) to six genera (about 10 species) in the distance from Bramble Cay to Port Jackson (recent work will enlarge these numbers, e.q. Wells, 1962). The decrease in variety of the fauna is, in the main, attributable to changes in environmental necessities of the hermatypic corals, which require warm, aerated, brightly lit waters. It is commonly stated that a minimum annual mean temperature of not less than 18° C. is required for the vigorous growth and development of the reef and its constituent corals. Individual component species of the reef fauna, being more tolerant of temperature, however, stray beyond the limits of the reef proper. This extension is not abrupt, but gradual, with species interrelationships changing with the environment (Squires, 1959).

Ahermatypic corals, on the other hand, are not so stringently limited. Indeed, some genera range from polar seas to the tropics and may be collected from shallow waters a few metres deep to nearly abyssal depths. Distributional data for these corals are even more incomplete than those for the hermatypic, and inferences concerning environmental factors affecting their distribution, drawn from records of their occurrence, must be treated with caution because of the wide spectrum of ecologies through

which these corals are distributed. The rhizangiid corals are commonly encountered in the littoral of the temperate regions and range into tropical areas, where they may be associated with the reef corals. Although subordinate and inconspicuous on the reefs, these corals constitute a significant component of temperate littoral faunas.

From a variety of criteria, not the least of which is physiographic, the southern extremity of the Great Barrier Reef may be taken as Lady Elliot Island. Individual species of hermatypic corals extend to the south, completely surrounding Australia in their distribution. For example, Wells (1955a, 1962) noted the occurrence of *Coscinaraea, Cyphastrea, Montipora, Plesiastrea, Stylocoeniella* and *Turbinaria* at the latitude of Sydney. This list will undoubtedly be enlarged as exploration of the Port Jackson region is continued particularly through the use of SCUBA. The west coast of Australia has not been fully studied as yet. However, Hodgkin, Marsh and Smith (1959) and Wells (1962) record *Coscinaraea, Favites, Goniastrea, Homophyllia, Montipora, Oulophyllia, Platygyra, Plesiastrea, Pocillopora, Tubastrea* and *Turbinaria* from the vicinity of Rottnest Island. It is probable that this fauna extends southward to Cape Leeuwin.

In the following discussion, hermatypic corals occurring from Port Jackson south to Bass Strait, and westward to Cape Leeuwin will be considered. Of the ahermatypic corals, only those recorded as occurring in Port Phillip will be listed.

Quoy and Gaimard (1833) recorded *Astrea galaxea* Lamarck [*Plesiastrea urvillei* Milne–Edwards and Haime] from King George Sound. This is, apparently, the first description of a South Australian coral. Tenison–Woods (1878) stated that the only corals to be found on the south and southeastern coasts are: *Homophyllia australis* Milne–Edwards and Haime; *Cyphastrea micropthalma* Lamarck and *C. muelleri* Milne–Edwards and Haime, both ". . . probably found on the S. E. coast, near Port Jackson, though I have no well-authenticated habitat"; *Plesiastrea urvillei* Milne–Edwards and Haime; *P. peronii* Milne–Edwards and Haime; and *Lophoseris*, [— *Pavona*] from Manly Beach, Port Jackson.

In his description of *Plesiastrea proximans*, which was collected in St. Vincent's Gulf, at a depth of 22 fathoms, Dennant (1904, p. 9) states "This species differs in shape, as well as in other respects, from the common *Plesiastrea* found in Port Phillip Bay. The latter is probably identical with *P. urvillei*, Edwards and Haime". Dennant (1906) also described *Homophyllia incrustans*, from St. Vincent's Gulf, but this appears to be an immature rhizangiid coral, rather than a hermatypic form.

Howchin (1909) described masses of *Plesiastrea urvillei* from Gulf of St. Vincent which were over 7 feet in greatest length. Literature dealing with South Australian corals was also summarized.

Totton (1952) figured specimens of *Culicia magna* [*Homophyllia australis*], *Culicia tenella* and *Plesiastrea urvillei* from South Australian waters.

Wells (1955b) listed *Pavona, Cyphastrea,* and *Turbinaria* as ranging south to Sydney, ". . . while *Plesiastrea urvillei* continues more or less continuously around the south coast of Australia", and later (Wells, 1962)

stated "*Plesiastrea urvillei* and *Homophyllia australis* are exceptional in that their northern limit seems to be at or near Houtman's Abrohlos (29 30′ S.) in the west, but they extend down and around the southern coast of Australia . . ., the northern coast of Tasmania, and north probably as far as Moreton Bay, Queensland (27° 30′ S.)".

The distribution of these hermatypic corals is summarized in the following table:—

DISTRIBUTION OF HERMATYPIC CORALS OCCURRING ON THE SOUTHERN AND SOUTHEASTERN COASTS OF AUSTRALIA.

Species.	*Port Jackson.*	*Port Phillip.*	*St. Vincent's Gulf.*	*Spencer Gulf.*	*King George Sound.*	*Rottnest Island.*
Coscinaraea mcneilli	×	—	—	—	—	—
Cyphastrea micropthalma	×	—	—	—	—	—
Cyphastrea muelleri	×	—	—	—	—	—
Montipora sp.	×	—	—	—	—	—
Pavona cristata	×	—	—	—	—	—
Pocillopora damicornis	×	—	—	—	—	×
Stylocoeniella sp.	×	—	—	—	—	—
Turbinaria sp.	×	—	—	—	—	—
Plesiastrea urvillei	×	×	×	—	×	×
Plesiastrea peroni	×	—	×	×	—	—
Plesiastrea proximans	—	—	×	—	—	—
Homophyllia australis	—	×	×	×	—	×
Coscinarea marshae						×
Favites abdita						×
Favites magnistellata						×
Goniastrea benhami						×
Oulophyllia crispa						×
Platygyra sp.						×
Tubastrea aurea						×
Turbinaria diaphana						×

Papers dealing with the ahermatypic corals of the southern Australian waters include those of Dennant (1904, 1906), Moseley (1881), Hoffmeister (1933) and Wells (1958). A listing of the shelf corals of southern Australia was given in Squires (1961).

Ahermatypic corals recorded from Port Phillip Bay are not numerous. Dennant (1904) listed *Rhizotrochus radiatus* Dennant [= *Monomyces radiatus*], *Cylicia rubeola* Quoy and Gaimard [= *Culicia hoffmeisteri*] and *Balanophyllia dilatata* Dennant.

Specimens collected on the present survey of Port Phillip were recorded by Areas and stations. Positions of these are shown on Charts 1 and 2 (back of volume).

Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171 Port Phillip with the numbered Area grid super-imposed.

Chart 2 shows position of the stations numbered 1—317 with the same grid super-imposed to aid in location of the stations and for correlation with depth &c. Localities in the text are shown as area number followed immediately by the station number in brackets.

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Table A records station number, date, method of collecting (dive or dredge) and depth in fathoms.

Order **Scleractinia** Bourne, 1900.

Suborder **Faviina** Vaughan and Wells, 1943.

Family Faviidae Gregory, 1900.

Genus *Plesiastrea* Milne–Edwards and Haime, 1848.

Type species: *Astrea versipora* Lamarck, 1816, by monotypy.

Plesiastrea urvillei Milne–Edwards and Haime, 1848.

Pl. 1, Figs. 6, 7.

Astrea galaxea: Quoy and Gaimard, 1833, Voyage de l'Astrolabe, Zoophytes, p. 216, pl. 17, figs. 10–14.

Plesiastrea urvillei Milne–Edwards and Haime, 1848, Ann. Sci. nat., ser. 3, vol. 12, p. 117. 1850, *ibid*, vol. 10, pl. 9, fig. 2.

Plesiastrea peroni Milne–Edwards and Haime, 1857, Histoire Naturelle Coralliaires, vol. 2, p. 492, pl. D 7, fig. 3.

Plesiastrea proximans Dennant, 1904, Trans. and Proc. Roy. Soc. South Australia, vol. 28, p. 9, pl. 2, figs. 3a, b.

Milne–Edwards and Haime differentiated between *P. urvillei* and *P. peroni* on the basis of the number of septa occurring in the calices. I prefer to consider the two species identical. *P. peroni* has three complete cycles of septa (24 in number); in *P. urvillei* the third cycle is complete, and portions of the fourth cycle of septa are present, the number of septa being, usually, in excess of 30. I can find no basis for the separation of *P. proximans* Dennant from this species. The shape of the corallum is a very untrustworthy character upon which to base a species, particularly in encrusting colonial corals.

Distribution. Coast of New South Wales southward to Bass Straits, west to King George Sound, north to Houtman Rocks.

Collecting Notes—*Plesiastraea urvillei* is known to occur in quantity in four areas of Port Phillip; off St. Kilda, Area 3 (203); off Point Cook, Area 5 (56); off Mentone, Area 14 (4 and 5), off Balcombe Bay, Area 55 (148), and off Port Lonsdale, Area 58 (90). The substratum in each case is Miocene ironstone " reef " outcropping on a sea bed of coarse sand and broken shell, at approximate depths of 10–20 feet.

The coral forms loosely attached hemispherical colonies on the " reef " and also on dead colonies of the same species. Juveniles always establish themselves on the upper surface of the substratum but may grow down and under the lip of ledges as the colony increases in size. Well established colonies may be eighteen inches in diameter. Coral covers approximately 20 per cent. of the surface of the " reefs " while algae covers an additional 25 per cent.

Unlike some species of tropical coral (Port Phillip sea temperature range is 9°—23° C) this species seems able to withstand a certain amount of sediment in the water. Port Phillip always has a large quantity of suspended matter in the water, particularly at the northern end, and during some seasons the concentration is very high.

Family MUSSIDAE Ortmann, 1890.

Genus *Homophyllia* Brueggemann, 1877.

Type Species: *Caryophyllia australis* Milne–Edwards and Haime, 1849, by monotypy.

Homophyllia australis (Milne–Edwards and Haime, 1849).

Pl. 1, Figs. 4, 5.

Carophyllia australia Milne–Edwards and Haime, 1849, Ann. Sci. Nat. Zool., ser 3, vol. 11, p. 239; *ibid*, vol. 10, pl. 8, fig. 2.

Homophyllia australis (Milne–Edwards and Haime); Wells, 1964, Zoologische Mededelingen, vol. 39, p. 378.

Culicia magna Tenison–Woods; Totton, 1952, Ann. Mag. Nat. Hist., ser. 12, vol. 5, p. 975, pl. 36, figs. 9–11.

Seven specimens of this species were seen. They are all larger than those previously described, being up to 30 mm. in diameter. This does not seem to be significantly diagnostic to warrant distinguishing the specimens as a separate species. Most of the specimens are fairly regular in outline, being essentially simple mussid corals. Three, however, are highly contorted with the calicular margin being deeply invaginated. No separation of centers has occurred in these specimens, the invagination apparently resulting from crowding of the specimens. Wells (1964) gives 10 to 12 dentations per cm. of septum as a diagnostic character and the present specimens fall in this range.

Distribution : Southern Australia from Rottnest Island to Port Phillip. Lord Howe Island?

Collecting Notes—*Homophyllia australis* was collected only at Mornington, Area 55.

Family RHIZANGIIDAE d'Orbigny, 1851.

Genus *Culicia* Dana, 1846.

Type species: *Culicia stellata Dana*, subsequent designation Wells, 1936.

Culicia hoffmeisteri, n. sp.

Pl. 1, Fig. 3.

Culicia tenella Dana; Hoffmeister, 1933, Biol. Res. Fishing Exp. F.I.S. "Endeavour", vol. 6, pt. 1, p. 11, pl. 3, figs. 1, 2.

[?]*Culicia rubeola* Quoy and Gaimard, Dennant, 1904, Trans. and Proc. roy. Soc. South Australia, p. 6.

Holotype: Australian Museum number E791. The specimen figured by Hoffmeister (1933) in pl. 3, figures 1, 2.

Type Locality: Forty Miles west of Kingston, South Australia, 30 fathoms.

Species of this genus are in need of revision, but large series of all species will be required to evaluate correctly variability in septal characters. As suggested by Wells (1954) the specimen described by Hoffmeister (1933) from off Kingston is not *C. tenella* Dana. In all probability, the specimens referred to as *C. rubeola* by Dennant are the present species. *Culicia tenella* and *C. hoffmeisteri* differ from *C. rubeola* in the presence of a deep notch in the larger septa adjacent to the wall of the corallite. *Culicia hoffmeisteri* differs from *C. australiensis* Hoffmeister (1933) from off Marsden Point, Kangaroo Island at a depth of 17 fathoms, in having non-exsert and more numerous septa.

Specimens referred to this species from Port Phillip Bay agree with the type and are as described for the species by Hoffmeister. The major septa are very broadly lobed near their summit and are separated from the wall by a distinct notch. The proximal edges of these septa are not highly dentate. All other septa, however, are dentate, those of the second cycle more broadly and coarsely so. Tertiary septa may have as many as eight dentations on the proximal edge of the septa. All septa extend to the center of the calice where their proximal teeth merge with the long rod-like papillae of the columella.

All of the specimens examined are covered by calcareous algae to their summits.

In addition to the specimens from Port Phillip, I have examined the types of *C. tenella* (U.S.N.M. 184) and of *C. hoffmeisteri* at the Australian Museum.

Distribution : Known only from Port Phillip and from Kingston, South Australia.

Collecting Notes. *Culicia hoffmeisteri* was collected at Popes Eye, Area 59 (36), where it was associated with *Monomyces radiatus* on rocky substrates.

Suborder Caryophylliina, Vaughan and Wells, 1943.

Family FLABELLIDAE Bourne, 1905.

Genus *Monomyces* Ehrenberg, 1834.

Type Species: *Monomyces anthophyllum*, subsequent designation Milne-Edwards and Haime, 1850.

Monomyces radiatus (Dennant, 1904).

Pl. 1, Figs. 1, 2.

Rhizotrochus radiatus Dennant, 1904, Proc. roy. Soc. South Australia, vol. 28: p. 2, pl. 1, fig. 1a, 1b.

In all respects this coral closely resembles *Flabellum rubrum* from the New Zealand coasts, with the exception of the presence of hollow rootlets which places the specimens in the genus *Monomyces*. In contrast to Dennant's statement concerning the constancy of the number of these rootlets, they seem to occur in direct response to the needs of the polyp in stabilizing the corallum. As such, the position and number of rootlets cannot have any significance taxonomically. The specimens in the present collection are all smaller than the type specimen, the largest being 13 mm. in greater calice diameter.

Younger specimens display toothed septa, the teeth being trabecular rods projecting upward and outward from the proximal edge of the septum at very slight angles. As the corals grow, the intervals between these teeth are filled in and the septum becomes solid with a smooth proximal edge; a condition more typical of the Flabellidae.

Although most of the specimens have lost their color during preservation, one shows a " coral " oral disc with white tentacles. The tentacles in the preserved specimens are long and coarsely knobbed with nematocyst batteries and bear a terminal battery. The stomadeum is ridged.

Distribution : Known only from Port Phillip.

Collecting Notes. *Monomyces radiatus*. Popes Eye, Area 59 (36), Ocean Beach, Point Nepean, Area 58, (290), in a rock pool at a depth of 10 feet.

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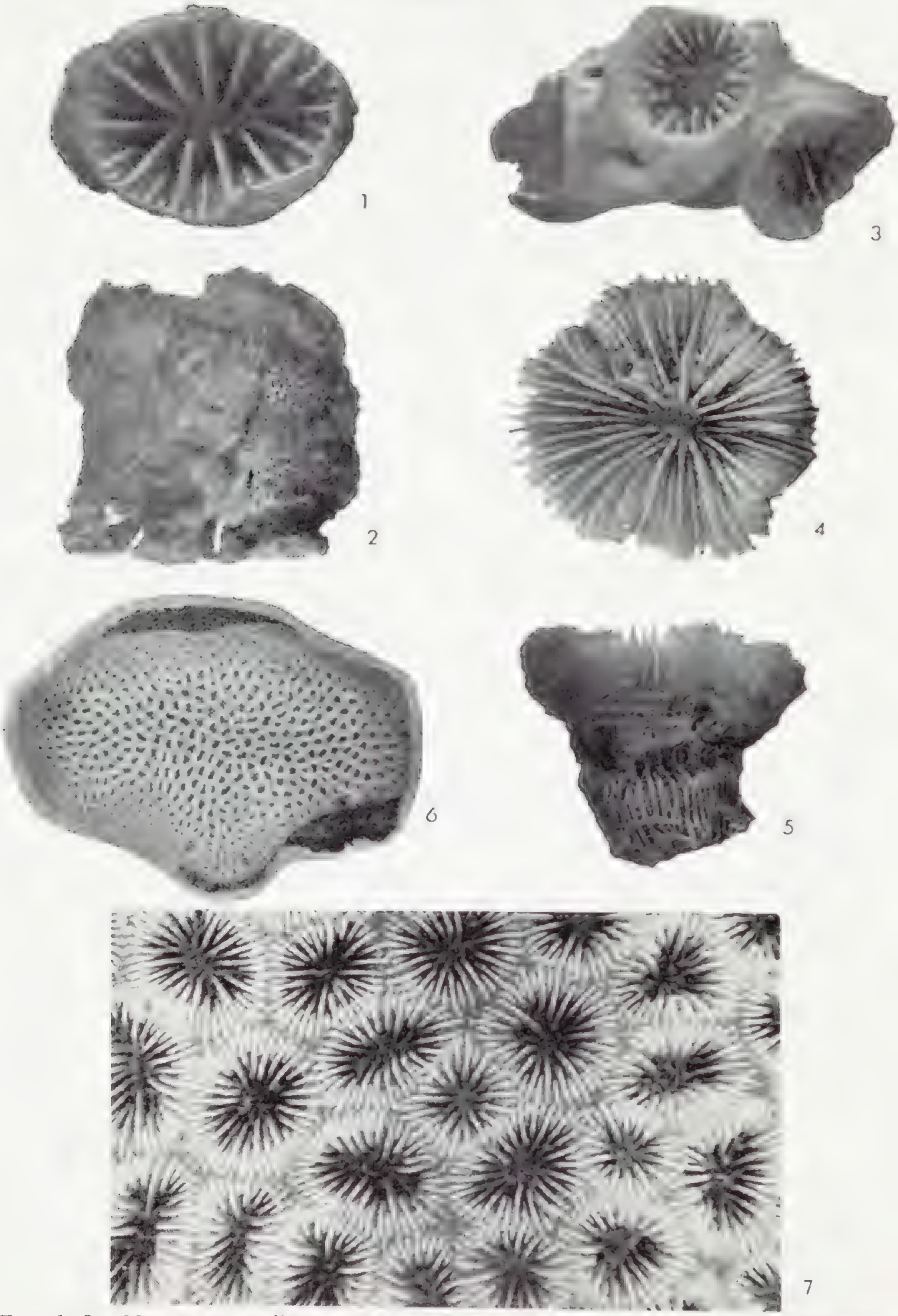
PLATE 1.



FIGS. 1, 2. *Monomyces radiatus* Dennant. Fig. 1, Calice, x 3·3; Fig. 2, corallum showing rootlets, x 00.

FIG. 3. *Culicia hoffmeisteri* Squires, *n.sp.* Corallum, x 3·3.

FIGS. 4, 5. *Homophyllia australis* (Milne–Edwards and Haime). Fig. 4, Calice, x 1·5; Fig. 5, corallum showing parricidal budding, x 1·5.

FIGS. 6, 7. *Plesiastrea urvillei* (Milne–Edwards and Haime). Fig. 6, corrallum, x 0·33; Fig. 7, calices, x 8·0.

PORT PHILLIP SURVEY 1957–1963.

SIPUNCULOIDEA AND ECHIUROIDEA.

By *S. J. EDMONDS.*

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SUMMARY.

Sipunculoids and echiuroids were poorly represented in the survey collections, but amongst the nine complete specimens collected, there were two possibly new species and two new records for Victoria. One species *Bonellia* sp., of which only the proboscis was collected, was in large numbers in the northern half of the bay.

INTRODUCTION.

Sipunculoids and echiuroids are wormlike, marine invertebrates. Although some similarities are found in their structure and habits they belong to two different groups or phyla of animals. Although they are regarded as belonging to " minor " phyla, sipunculoids and echiuroids, especially the former, are not uncommon and are found in tropical, temperate, arctic and antarctic waters. They have been collected between tide-levels from most of the sea-shores of the world and they have been dredged, sometimes at considerable depths, from the floor of the oceans.

They are detritus-feeders. They ingest large quantities of sand, mud, rock or coral fragments from their environment and extract from it any organic matter that it may contain.

Sipunculoids differ most noticeably from echiuroids in that they possess an anteriorly placed organ, called an introvert, which can be extended in front of the body of the animal or retracted within it. Echiuroids possess an anterior proboscis that extends in front of the animal but which cannot be retracted within the body. The anal aperture of a sipunculoid is an anteriorly placed structure and is always situated at the base of the introvert. The anal aperture of an echiuroid, on the other hand, is situated at the posterior extremity of the worm. A pair of setae is always present on the ventral surface of an echiuroid near its mouth.

The most recent and the most helpful papers on the classification of both sipunculoids and echiuroids are those of W. F. Fisher (Fisher 1946 and 1952). Papers on Australian sipunculoids are those of Edmonds (1955 and 1956) and of echiuroids those of Johnston and Tiegs (1920), Edmonds (1960 and 1963) and Nielson (1963). Keys to the Australian genera are given in Edmonds (1956 and 1963). A general account of the two phyla is contained in Hyman (1959).

The collection of animals from Port Phillip contained four sipunculoids and five echiuroids. The sipunculoids comprised three species and the echiuroids three, possibly four, species, one of which is represented only by its long proboscis.

Sipunculus angasi Baird was not collected on the present survey possibly because it is usually buried beneath the surface in the daytime when most of the collection was done. Edmonds 1955 records it from Portarlington (Area 29), Brighton (Area 7), Black Rock (Area 14), Hobsons Bay (Area 2 and 3), Rosebud (69), Queenscliff (Area 58–9).

SPECIES AND LOCALITIES.

PHYLUM SIPUNCULOIDEA.

1. *Phascolosoma noduliferum* Stimpson: 1 specimen. Locality, Area 59 (24).
2. *Golfingia* sp.: 1 specimen. Locality, Area 68 (154) from sand, broken shell and weedy bottom.
3. *Dendrostomum* sp.: 2 specimens. Localities, Area 55 (144); Area 27.

PHYLUM ECHIUROIDEA.

1. *Anelassorhynchus adelaidensis* Edmonds: 1 specimen. Locality, Area 55 (39).
2. *Bonellia gigas* Nielsen 1 specimen. Locality, Area 30 (130) and two small specimens tentatively assigned to this species from locality Area 55 (39).
3. *Bonellia* sp.: 10 specimens. Localities Area 35 (121), 24 (122), 36 (76). Area 23 (7), Area 5 (–), Area 55 (35), Area 14 (4).
4. *Arhynchite hiscocki* Edmonds: 2 specimens. Locality, Area 48.

DETAILS OF SPECIES.

A. *SIPUNCULOIDEA*.

1. *Phascolosoma noduliferum* Stimpson, 1855.

This species was identified by (1) the structure of the papillae on the surface of its body and (2) the structure and size of the hooks on its introvert. The species was redescribed by Edmonds (1956). It has been reported previously from N.S.W., Victoria and Tasmania (Edmonds 1956).

2. *Golfingia* sp.

The single specimen was small and its introvert almost completely retracted. No hooks or spines were found on the introvert when it was dissected. The tentacles were of the type found in *Golfingia* and not in *Dendrostomum*. The fact that four retractor muscles were present indicates that the species is not *Golfingia margaritacea adelaidensis* Edmonds 1956, known from South Australia. Possibly it is a new species but more specimens will be required for examination before this can be decided.

3. *Dendrostomum* sp.

Both specimens were small and under 1 cm. in length. This makes dissection difficult. They were both of the genus *Dendrostomum* but whether *D. cymodoceae* Edmonds, 1956 or *D. signifer* Selenka, 1883, was not able to be determined.

B. *ECHIUROIDEA*.

1. *Anelassorhynchus adelaidensis* Edmonds, 1960.

The specimen consisted of a sac-like structure about 90 mm. long and a slender, deciduate proboscis about 55 mm. long that was flattened somewhat anteriorly. The musculature of the body wall was continuous and not divided into bundles. On dissecting the specimens two pairs of nephridia, arising posteriorly to the level of the setae, were found to be present. The nephrostomal lips of the nephridia were spirally coiled. No cloacal caecum was present. The colour of the animal preserved in alcohol was pale pink but since the alcohol was greenish in colour it is probable that in life the animal was green. I have found the specimen similar to specimens of *A. adelaidensis* that I have in my possession.

A. adelaidensis was described from specimens found among the sand and debris that accumulates amongst the roots of marine angiosperms and the holdfasts of algae in St. Vincent Gulf, South Australia. This is the first record of the animal in Victoria.

2. *Bonellia gigas* Nielsen, 1963.

The anterior extremity of the proboscis of a bonellid is forked. The trunk of the specimen from area 31 was sac-like and about 35 mm. long and 23 mm. wide (maximum). The proboscis was about 40 mm. long and its forked arms about 15 mm. The intestine was filled with small elliptically shaped pellets of faecal material. No intestinal caecum was present. A single nephridium that contained a male animal and about 100 eggs was present. The nephrostomal opening was placed towards the distal end of the nephridium and its lips were much folded and wrinkled. There seems to be little doubt that the animal is a smaller specimen of *B. gigas* described from Victoria by Nielsen (1963).

Two other bonellids, much smaller in size, were also contained in the collection. Both were damaged to some extent. The shape of the setae corresponded with that *B. gigas* rather than *B. haswellianus* Johnston and Tiegs (1920). Both were green in colour and possessed a single nephridium. I have tentatively assigned them to *B. gigas*. *B. gigas* has been found only in Victoria.

3. *Bonellia* sp.

At least ten probosces of this species were collected and large numbers of others were seen extruded and seeking food on the surface of the sandy mud which they inhabit. In spite of numerous efforts to collect the whole animal all attempts have so far failed.

The portion collected is flat approximately 18 mms. wide and anything up to a metre in length. According to divers' reports, it moves with an undulating motion over the surface. As soon as it is disturbed it is rapidly withdrawn or if touched at the point of extrusion above the surface, breaks off and swims free." The nature of the substratum, fine silty sand or sandy mud, makes digging difficult as holes tend to fall in immediately and at the same time any movement stirs up the fine surface sediments reducing visibility to nil.

4. *Arhynchite hiscocki* Edmonds, 1960.

The two specimens were long and slender, grey-green in colour with prominent white papillae as preserved in formalin. The length of the trunk of the two specimens was 11 and 12 cm. and the maximum width (in the middle third of the animal's length) 1–1·2 cm. The proboscis is short—much shorter than that of the type specimen—and is deciduate. It is flattened at its anterior extremity so as to resemble a shallow spoon. Two prominent setae are present and are placed just near the mouth. The nephridia are long (about one third of the body length) and slender and the nephrostomal lips are frilled and leaf-like. The interbasal and setal muscles are very well developed. There are two long, brownish-coloured anal vesicles that are fixed in position by mesenteries to the alimentary canal and to the posterior region of the body wall. *A. arhynchite* was described from Dunwich, Brisbane. This record from Port Phillip is new.

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PORT PHILLIP SURVEY 1957–1963.

SESSILE BARNACLES THORACICA, CIRRIPEDIA.

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SUMMARY:

Of the three species of barnacles occurring in Port Phillip Bay one, *Elminius simplex* belongs more properly to the fauna of the open coast and the other two species, *Balanus variegatus cirratus* and *Elminius modestus* are well-known fouling species with distributions in Australian seas and beyond.

INTRODUCTION.

The collections made during the Survey of Port Phillip in Victoria have revealed that the sessile barnacles play a comparatively minor role in the Bay fauna. Only three species of two genera were represented, as follows:—The common fouling species, *Balanus variegatus cirratus* Darwin, *Elminius modestus Darwin* and *E. simplex* Darwin. Of these, *Balanus variegatus cirratus* was commonest, *Elminius modestus* is apparently less common than it is in other Australian inlets and bays and *E. simplex* is included only on the strength of a single record which is actually outside the " Bay " proper, on the open sea coast.

Both genera from Port Phillip belong to the family *Balanidae* but are easily distinguishable from one another by the number and internal structures of the plates forming the outer whorl of the shell. *Balanus variegatus* has six plates articulated together to form the shell crown and each of these plates, when broken across horizontally, possesses a row of pores—hollow tubes running from the basis towards the top of the shell plates, between its outer and inner lamina. In the genus *Elminius*, on the other hand, there are only four shell plates which, when broken across, are quite solid and consequently thinner than those of *Balanus*. Detailed descriptions of the shell structures of these species, together with illustrations of the important opercular plates, have previously been recorded by the author (Pope, 1945) and will not be repeated here. Their occurrence in Port Phillip and some remarks about each species are set out below.

Genus *Balanus*.

Balanus variegatus var. *cirratus* Darwin.

Balanus amphitrite var. *cirratus* Darwin, 1854, p. 241, Plate 5, fig. 2b. Pope, 1945, pp. 362–3, Plate XXVIII., fig. 6, and Plate XXX., figs. 13 and 14.

Balanus variegatus var. *cirratus* Harding, 1962 pp. 293–4, Plate 10, figs. 1–n.

This barnacle which is one of the most troublesome of local fouling species has hitherto been known in Australian literature as *Balanus amphitrite* var. *cirratus* Darwin. Harding (1962), after re-examining

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Darwin's material in the light of modern usage in the systematics of cirripedia, split Darwin's unwieldy species-complex of *B. amphitrite* into four separate species. According to this new arrangement the commonest barnacle taken by the Port Phillip Survey should now be known as *Balanus variegatus* var. *cirratus* Darwin.

In making this change, Harding pointed out that Darwin himself had inclined towards creating a separate species for " var. *cirratus* " since the differences he observed between it and other varieties of the *B. amphitrite* complex seemed to him to be of specific rank. However, because he noticed its close affinities with *variegatus*—a New Zealand variety which he had already included in the species *amphitrite*—he lumped *cirratus* in with the rest of the *amphitrite* complex. Dr. Harding has now elevated Darwin's " variety *variegatus* " to specific rank and made *cirratus* a variety within it.

The collections made during the present survey record *B. variegatus cirratus* in every month of the year except September and its distribution in the Port in widespread, north from a line drawn from Martha Point and St. Leonards to the head of the Bay. The vertical distribution recorded ranged from the intertidal zone down to a depth of 6 fathoms, and it was recorded growing on harbour structures, on the mussel (*Mytilus*) and other benthic animals.

Balanus variegatus cirratus is tolerant to silt and other suspended matter and can withstand widely varying salinities and a number of the chemical wastes of the kind that are poured into rivers and bays. It can therefore be expected to be widely distributed in Port Phillip.

The shell of this moderately sized species has a basal diameter in well-grown specimens of up to 18 mm. and a height of about 10 mm. but is often smaller than this. It may have either a regular, conical shape or, if growing in a crowded space, may assume a cornucopia-like shape and be up to 20 mm. or so in height. The ultimate shape is brought about by differences in the method of growth of the white basis section. This is flattened and closely cemented to the substratum in conical forms but is shaped something like a tall tumbler (tapering to a narrow base) in specimens which grow in crowded situations.

The central or parietal areas of each plate are alternately banded by dirty white and mauve stripes which are intersected horizontally by purple-brown bands running round the shell. This produces a generally flecked appearance. The radii of the shell plates lack flecks and are generally a mauvish-pink colour. The orifice of the shell is often toothed (where the summits of the parieties project) and the carinal shell plate often forms a spout-like projection. For further details of shell structure reference should be made to Harding's (1962) paper, pages 291–296 and plate 10 in which a 'Key to Darwin's " Varieties " ' is included or to Pope (1945) where it is illustrated under the name of *B. amphitrite cirratus*.

Genus *Elminius*.

This genus is represented in the present collections by both of the Australian species, *Eliminius simplex* and *E. modestus*. They are easily separable because of their differing shell structures and habitat preferences.

The following key will help to separate the two species by means of superficial characters:—

Key to Australian Species of Genus *Elminius*.

(1) Shell white, steeply conical and generally highest on the carinal side of the shell crown; with well-marked ribs; and a basal diameter of 12–13 mm. in mature specimens. The orifice of the shell is relatively small. Habitat: The lower surfaces of boulders, or under ledges and in caves near low water mark of spring tides; generally on the oceanic coast, in fully saline waters. . . . . *E. simplex*.

(2) Shell greyish, much flatter than the above species and with each shell plate showing two low folds (rather than regular ribs). The carinal plate is generally produced into a sharp, spout-like projection and the diamond-shaped orifice is comparatively much larger than it is in *E. simplex*. Basal diameter 6–7 mm. but it can reach 10 mm. in favourable habitats. Grows between high water and low water of neap tide, on shore rocks, harbour structures, boats or on molluscs. It is tolerant of reduced salinities and silt and thrives where there is little water movement, other than tidal, e.g., in inlets, bays and river mouths. . . . . *E. modestus*.

As the ecological niches of *E. modestus* and *B. variegatus cirratus* overlap to a certain extent, some care is needed in determining the species of barnacles growing on intertidal areas of harbour structures or on the corresponding zone on the shore. As the shells of barnacles in calmer waters are often covered by other marine growths or obscured by deposits of silt it may be difficult to see details of shell structure. However, even a perfunctory cleaning of the shell crown generally suffices to show whether it is made up of six plates (*Balanus*) or four plates (*Elminius*). The two species of *Elminius* recorded in the present survey are as follows:—

Elminius simplex Darwin.

Elminius simplex Darwin, 1854, pp. 353–4, Plate 12, fig. 3. Pope, 1945, p. 370, Plate XXIX., fig. 5, and Plate XXX., figs. 25 and 26.

Elminius simplex is somewhat solitary in habit, occurring sporadically throughout its geographical range in south-eastern Australia. It is therefore not surprising that only a single specimen was taken during the present survey. The western extremity of its range is near Cape Otway and this record, in a locality lying just outside the heads of Port Phillip proper on Point Nepean, is an interesting addition to our knowledge of its distribution.

Elminius modestus Darwin.

Elminius modestus Darwin, 1854, pp. 350–351, Plate 12, fig. 1a–1e. Pope, 1945, pp. 368–370, Plate XXIX., fig 4, and Plate XXX., figs. 27 and 28.

It is perhaps a matter for some surprise that the present survey has recorded *Elminius modestus* in only one locality, namely, Safety Beach, Martha Point where it was attached to rocks near low tide level or on molluscs. It is also recorded from wharf piles growing at its normal level (near high water neap tide) at St. Leonards. These latter specimens are in the collections of the Australian Museum, Sydney.

It is likely that systematic searching of wharf piles or shore rocks to the north of these two localities would reveal that *E. modestus* is common in Port Phillip Bay, for there seems to be no reason to prevent its spread and growth, and its abilities to colonise and travel along sea coasts have been recorded by numerous European authors since its invasion of English waters in 1943.

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PORT PHILLIP SURVEY 1957–1963.

ISOPODA.

by E. NAYLOR.

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SUMMARY.

Twenty-six species of isopod crustaceans have been identified from Port Phillip. Synonymies are given for each species and, where necessary, descriptive notes are given. A table, map and appendix are given illustrating areas within the bay where each species was collected.

INTRODUCTION.

This paper gives an account of the Crustacea: Isopoda collected during the ecological survey of Port Phillip throughout the period 1957–1963. It gives brief synonymies of each species identified and, where necessary adds to their descriptions, besides also commenting upon patterns of species distribution which are apparent within the Bay.

IDENTIFICATION AND SYNONYMY.

Many of the genera recorded here have been identified using keys given by Hansen (1906), Hale (1929) and Hurley (1961), and many of the species, too, are identifiable in the keys given by Hale (1929). Additional literature used for identification is scattered and is discussed separately for each species, all of which are listed below in a classification which follows that of Hurley (1961).

TRIBE VALVIFERA.

Family IDOTEIDAE.

Paridotea munda Hale.

Paridotea munda Hale [Hale 1924b, Hale 1929, Nierstrasz 1941].

Five specimens (1 ♂ 23·0 mm. body length, 4 juveniles) agree with Hale's (1924b, 1929) descriptions of this species which previously has been recorded in southern Australia and Tasmania (Nierstrasz 1941).

Paridotea ungulata (Pallas).

Idotea ungulata (Pallas) [Miers 1881].

Paridotea ungulata (Pallas) [Hale 1924b, 1929, Nierstrasz 1941, Sheppard 1957, Hurley 1961].

Five specimens (1 ♂ 39·0 mm., 1 ovigerous ♀ 25·5 mm. 1 ♀ with oöstegite precursors 29·0 mm., 2 juveniles 27·5 mm.) agree with this species which is widely distributed in fairly shallow water throughout the Pacific, Indian and S. Atlantic oceans (Nierstrasz 1941, Sheppard 1957).

Crabyzos longicaudatus (Spence Bate).

Idotea longicaudatus (Spence Bate) [Miers 1881].

Crabyzos longicaudatus (Spence Bate) [Hale 1924b, 1929, Nierstrasz 1941].

One young female specimen (12·5 mm., with oöstegite precursors) agrees with this fairly common species from southern Australia.

Euidotea peronii (Milne Edwards).

Idotea peronii Milne Edwards [Milne Edwards 1840, Miers 1881].

Euidotea peronii (Milne Edwards) [Hale 1924b, 1929, Nierstrasz 1941, Hurley 1961].

One juvenile (10·0 mm.) agrees with this species which is said to be very common in S. Australia (Hale 1929) and which is also recorded from S. Africa (Nierstrasz 1941) and New Zealand (Hurley 1961).

TRIBE FLABELLIFERA.

Family EURYDICIDAE.

Cirolana woodjonesi Hale.

Cirolana woodjonesi Hale [Hale 1924a, 1929].

The sample contains a single immature specimen (14·5 mm.) of this common S. Australian species which is often found together with the next species (Hale 1929).

Cirolana australiense (Hale).

Cirolana cranchii Leach var. *australiense* Hale [Hale 1925, 1929, Nierstrasz 1931].

Cirolana australiense (Hale) [Naylor 1961, Hurley 1961].

The samples contain several specimens of this very common Australian species (Hale 1925, 1929, Nierstrasz 1931) which has also been recorded from New Zealand waters (Naylor 1961).

Neocirolana obesa Hale.

Neocirolana obesa Hale [Hale 1925, Nierstrasz 1931].

One specimen (6·5 mm.) keys out to this species in Hale (1925) where it was first recorded from New South Wales.

Family SEROLIDAE.

Serolis tuberculata (Grube).

Serolis tuberculata (Grube) [Hale 1929, Nierstrasz 1931].

One female (12·5 mm., with oöstegite precursors) of this moderately common southern Australian species occurs in the samples; it was taken from sand at low tide.

Family SPHAEROMIDAE.

Group HEMIBRANCHIATAE.

Zuzara venosa (Stebbing).

Cyclura venosa Stebbing 1876.

Zuzara integra Haswell [Haswell 1881b, 1882, Richardson 1907].

Cycloidura venosa Stebbing [Nierstrasz 1931].

Cycloidura integra Haswell [Nierstrasz 1931].

Zuzara venosa (Stebbing) [Baker 1910, Hale 1929].

Several males and females of this common and very distinctive species (see Baker 1910, Hale 1929) are present in the collections. There seems little doubt that the separate descriptions by Stebbing (1876) and Haswell (1881b) were of the same species, for which Stebbing's name *venosa* takes priority. The generic name *Zuzara* (Leach) is used here since it precedes that of *Cyclura* described by Stebbing (1876) (see also Hansen 1906).

Cymodoce bidentata Haswell.

Cymodocea bidentata Haswell 1881b.

Cymodoce bidentata Haswell [Baker 1926, Hale 1929].

One male (11·0 mm.) in the collections agrees closely with descriptions and figures of this species given by Baker (1926) and Hale (1929) except that the uropodal exopod of the present specimen is almost two-thirds the length of the endopod, which is longer than that illustrated by Baker (1926). In addition the present specimen has an additional pair of blunt tubercles situated slightly lateral to and behind the pair of upturned tubercles on the posterior part of the abdomen. The last feature is, however, described for *Cymodoce bidentata* var. *tasmanica* (Baker 1928), a variety whose status is perhaps worthy of investigation since present material came from the Australian mainland.

Cymodoce coronata Haswell.

Cymodocea coronata Haswell 1881b.

Cymodoce coronata Haswell [Baker 1928, Hale 1929].

Following Hansen (1906) and Hale (1929) specimens key out to the genus *Cymodoce* and they agree closely with Haswell's (1881b) original description of this species. However, there is some discrepancy between the original description and a description of this species given by Baker (1928), who, in addition, described two new varieties (*intermedia* and *fusiformis*) with which some present specimens also agree. In particular, whereas for the species Haswell (1881b) states that the mobile ramus (exopod of the uropod is much shorter than the immobile ramus (endopod), Baker's (1928) figure shows the uropodal exopod only slightly shorter than the endopod. Forms in which the uropodal exopod is considerably shorter than the endopod are grouped by Baker (1928) in the variety *Cymodoce coronata* var. *fusiformis*, whilst other forms which show an intermediate condition are grouped in the variety *C. coronata* var. *intermedia*. In view of this and until more material of a wide size range is available, present material is all included under Haswell's original name and descriptive notes of these are given below.

DESCRIPTION:—Body hirsute, particularly in adult males (Fig. 1a), clypeus (epistome) very broad (Fig. 1c), eyes bulbous, particularly in young forms (Fig. 1b). Peraeopods of adult male all with pads of spinous hairs, peraeopod 1 having a row of prominent blunt spines along the mesial border, peraeopods 6 and 7 with many long tapering spines. Penis fairly short and pointed, appendix masculina narrowing sharply about two thirds of the way along its length and projecting as a fairly slender structure for the last third of its length beyond pleopod 2 (Fig. 1d). Abdomen rather depressed, covered with hairs and ornamented with a coronet of six pointed tubercles, 2 on the posterior border of the anterior part of the abdomen and 4 on the posterior part (Figs. 1a,b). Adult male telson with wide terminal notch and a mesial lobe which is dilate at its base and narrow posteriorly (Fig. 1a); lateral teeth hardly visible from above in small specimens (Fig. 1b). Uropods of adult males with long endopod projecting well beyond telson and a much shorter exopod, each with a smooth terminal point (Fig. 1a). Younger specimens have uropod rami less pointed, more equal in size and not projecting beyond telson (Fig. 1b).

MATERIAL:—Ten specimens of this common southern Australian form occur in the Port Phillip material. Adult males ranged from 11·2—13·5 mm. body length, immature males with penes but unseparated appendix masculina ranged from 8·5—10·8 mm., and two possible young females resembling Fig. 1b measured 8·2 and 12·4 mm. respectively.

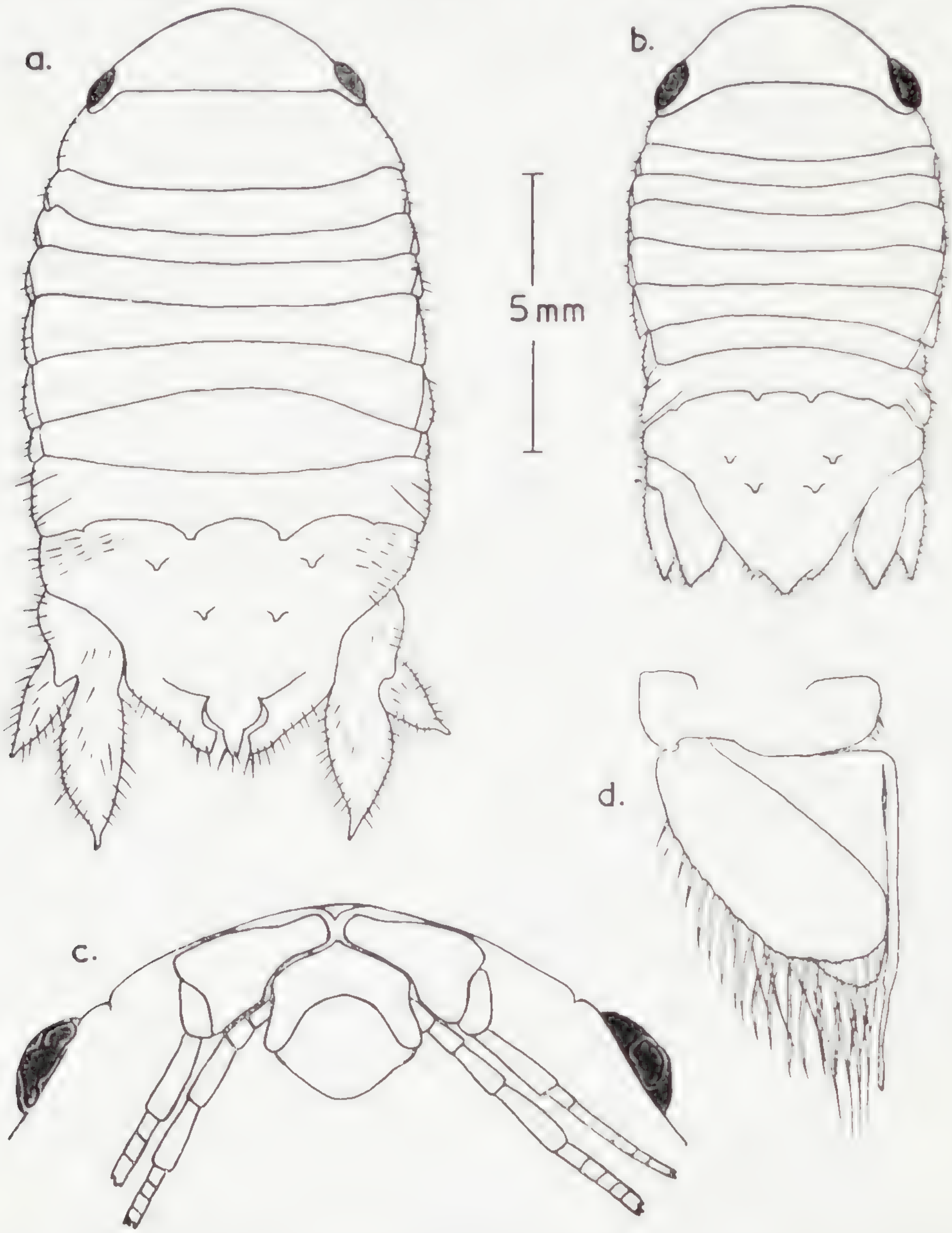

FIG. 1, *Cymodoce coronata* (*a*) adult of ♂ (*b*) young ♂ (*c*) ventral view of head of adult ♂ (*d*) appendix masculina of adult ♂.

Cymodoce gaimardii (Milne Edwards).

Sphaeroma gaimardii Milne Edwards 1840.

Cymodoce gaimardii (Milne Edwards) [Hansen 1906, Baker 1926, Hale 1929, Nierstrasz 1931].

Specimens key out to the genus *Cymodoce* (Hansen 1906, Hale 1926) and agree with brief descriptions of this species in Milne Edwards (1840) and Baker (1926). Descriptive notes and figures are included here to supplement rather limited information in the literature.

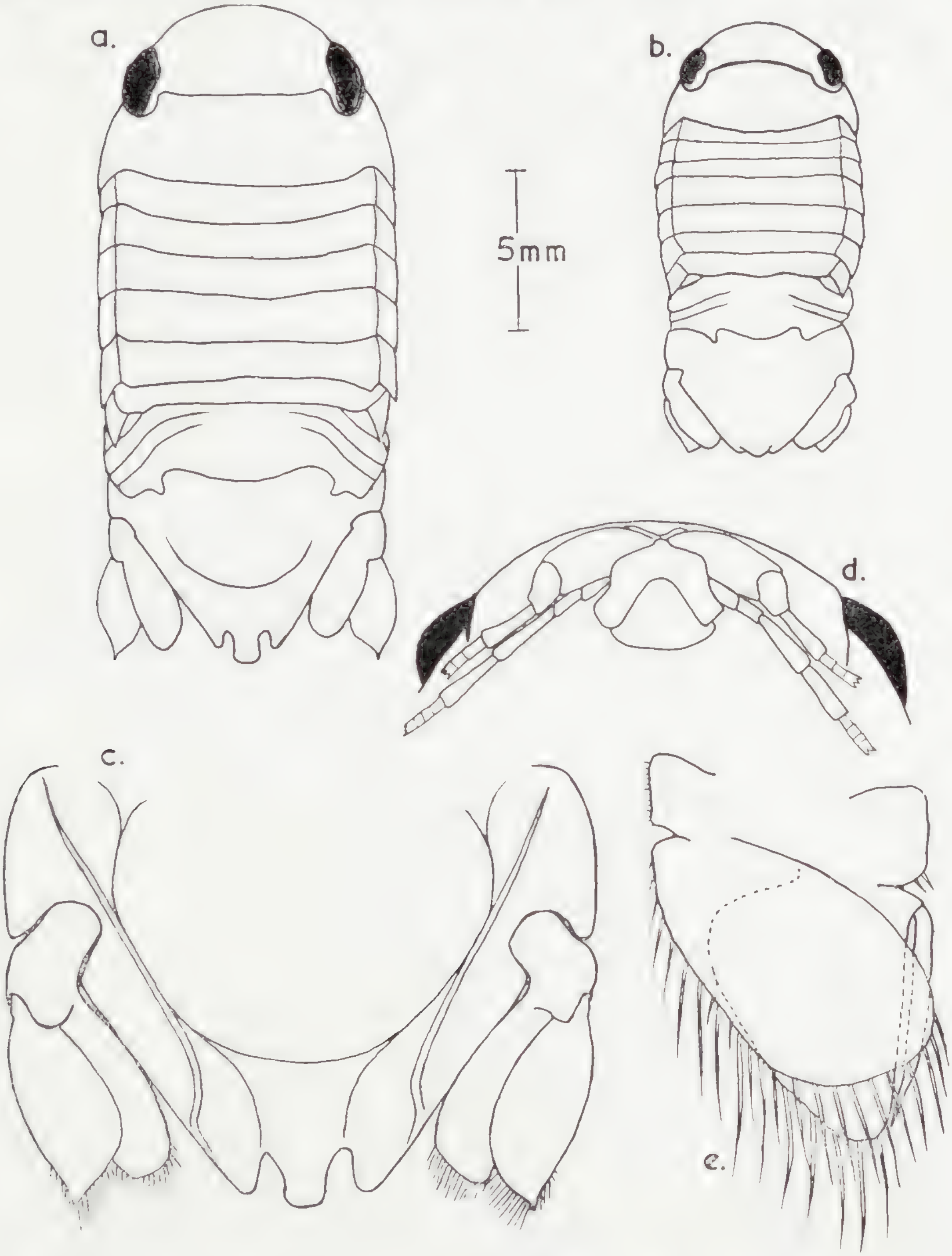

FIG. 2. *Cymodoce gaimardii* (*a*) adult ♂ (*b*) ♀ with oöstegites and reduced mouthparts (*c*) ventral view of ♂ telson (*d*) ventral view of ♂ head (*e*) appendix masculina.

DESCRIPTION:—Body smooth, clypeus broad, eyes fairly bulbous (Fig. 2 a, b, d). Peraepods of adult male all with dense pads of spinous hairs, peraeopod 1 with a row of prominent spines along the mesial border. Penes long and pointed, almost reaching posterior border of the exopod of pleopod 1 in fully mature specimens. Appendix masculina sharply pointed, almost reaching posterior border of endopod of pleopod 2 (Fig. 2e). Abdomen domed, with exopod of uropod extending as far as tip of telson in adult males (Figs. 2 a, c). Male telson trilobed, with median lobe square-cut (Figs. 2a, c). Telson border of immature males, juvenile and females less distinctly trilobed, with median projection bluntly rounded (Fig. 2b). Adult females have oöstegites on body segments 1–4 but incubate the brood internally; they have reduced mouthparts and, like males, have pads of spinous hairs on the peraeopods.

MATERIAL:—The collections contain 479 specimens of this species which is common on the coasts of southern Australia and Tasmania. Adult males ranged from 17·0—24·2 mm. body length, though some males up to 23·2 mm. were immature; ovigerous females ranged from 14·2—18·5 mm.

Cymodoce multidens var. *australis* Baker.

One specimen (7·0 mm. body length) from Port Phillip keys out to the genus *Cymodoce* (Hansen 1906, Hale 1929, Hurley 1961) and agrees very closely with the description and figures of this form described by Baker (1928) from W. Australia. Unfortunately when erecting this varietal name Baker (1928) made no comparison between his specimens and the original description of *C. multidens* from the Philippines given by Richardson (1910). With more material it would be useful to make such a comparison, for there appear to be differences particularly in the shape of the telson and the arrangement of spines on the head such that the Australian form should perhaps be designated as a separate species.

Cymodoce pubescens (Milne Edwards).

Sphaeroma pubescens Milne Edwards 1840.

Cymodoce pubescens (Milne Edwards) [Hansen 1905, Stebbing 1910, Nierstrasz 1931].

Paracilicaea (?) *pubescens* (Milne Edwards) [Baker 1926, Hale 1929].

Eight specimens key out to the genus *Cymodoce* (Hansen 1906, Hale 1929, Hurley 1961) and agree with descriptions of this species given by Milne Edwards (1840) and Stebbing (1910). Haswell's (1881a) description under this name seems more relevant to female *Cilicaea latreillei*, a species with which *Cymodoce pubescens* is often confused (see also Miers 1884). However, the presence in the Port Phillip material of adult males, like adult females, with both rami of the uropods well developed and without a median dorsal process on the anterior part of the abdomen (Fig. 3a) suggests that present specimens are correctly referred to the genus *Cymodoce*. Moreover, in the present investigation *Cilicaea latreillei* and *Cymodoce pubescens* were not found in the same areas (see Table 1 and Appendix). Baker (1926) doubtfully referred his material to *Paracilicaea pubescens* (Milne Edwards) and suggested that there might be two forms of male in this species, one with the uropodal endopod reduced and another with the uropodal rami subequal in size. Hale (1929) followed Baker in this interpretation but since there is no evidence of two male

types in present collections the Port Phillip specimens are referred to the genus *Cymodoce*. It remains to be seen whether additional males are found or whether the cilicaeform males with reduced uropodal endopods described by Baker (1926) are the males of some other species. A striking feature which separates *Cymodoce pubescens* from *Cilicaea latreillei*, apart from the median projection on the anterior part of the abdomen and the lack of uropodal endopods in adult male *Cilicaea latreillei*, is the fact that the body of *Cymodoce pubescens* is covered with a "pubescence" of evenly spaced, small flexible scale-like structures each associated with a flexible seta (Fig. 3c). In addition *Cymodoce pubescens* lacks the prominent tubercle which projects forwards from the clypeus of Port Phillip specimens of *Cilicaea latreillei* (see Figs. 3d, e) and the conical bosses on the posterior part of the abdomen are much less pronounced than in the latter species (see Figs. 3a, d, e). Present material of *Cymodoce pubescens* includes two males (11·0 and 13·5 mm.) each having long pointed penes and a long, whip-like appendix masculina (Fig. 3b). There are also three small males (each 10·5 mm.) with small, blunt penes and appendix masculina unseparated from pleopod 2, one female (11·5 mm.) with reduced mouthparts and oöstegites, and two juveniles (each 9·0 mm.).

Cymodoce tuberculosa Stebbing.

Cymodocea tuberculosa Stebbing 1873.

Cymodoce tuberculosa Stebbing [Whitelegge 1902, Baker, 1908, 1810, Hale 1928, Nierstrasz 1931].

Eight male specimens (5–6 mm. body length) key out to the genus *Cymodoce* (Hansen 1906, Hale 1929, Hurley 1961) and agree with descriptions and figures of this species given by Stebbing (1873), Whitelegge (1902), Baker (1910) and Hale (1929), though the last author does not mention the presence of four or five diagnostic large teeth which project forwards from the base of each antennule (see Baker 1910). This species seems to be fairly widespread in southern Australia (Nierstrasz 1931), often in the cavities of sponges (Baker 1910).

Cilicaea curtispina Haswell.

Naesa antennalis White 1847—nom. nud.

Cilicaea antennalis White [Miers 1884, Stebbing 1905].

Cilicaea antennalis Miers [Nierstrasz 1931].

Cilicaea curtispina Haswell [Haswell 1881b, Baker 1908, 1929, Hale 1929, Nierstrasz 1931].

One male (14·0 mm. body length) and two females (7·2 and 8·0 mm.) key out to the genus *Cilicaea* (Hansen 1906, Hale 1929, Hurley 1961) and agree with descriptions of *C. curtispina* in Haswell (1881b) (wno described the female) Baker (1908, 1928) and Hale (1929). The male specimen also agrees with a specimen in the British Museum (Nat. Hist.) labelled *Cilicaea antennalis* White (see also Miers 1884) which was listed by White (1847) as *Naesa antennalis* n.sp. This name clearly precedes that of Haswell (1881b) but it should probably be regarded as a *nomen nudum* since there appears to be no description accompanying the name in White (1847). Moreover, Miers' (1884) descriptive notes relevant to the specific name *antennalis* appeared later than Haswell's description of *C. curtispina*. The species is said to be very common in shallow water around the coasts of southern Australia.

Cilicaea latreillei Leach.

Naesa latreillei M. Edwards 1840.

Cilicaea latreillei Leach [Miers 1884, Stebbing 1905 Hale 1929, Nierstrasz 1931, Hurley 1961].

Cilicaea classicaudata Haswell 1881a.

Several Port Phillip specimens, including males (Fig. 3d) ranging up to about 11 mm. body length and females (Fig. 3e) ranging up to about 10 mm., key out to *Cilicaea* in Hansen (1906), Hale (1929) and Hurley (1961). All agree with descriptions of *C. latreillei* in Stebbing (1905) and Nierstrasz (1931) except that amongst present specimens adult males have uniramous uropods, not biramous structures as figured by the latter author. Moreover, a diagnostic feature on all present material is a prominent tubercle projecting forwards from the clypeus (Figs. 3c, d). The presence of this tubercle in both sexes clearly distinguishes *Cilicaea latreillei* from *Cymodoce pubescens*. In addition, though the appendix masculina is very long and slender, as in *Cymodoce pubescens*, the tip of this structure is more spatulate and not so finely pointed as in *Cymodoce pubescens* (Fig. 3f). *Cilicaea latreillei* is widely recorded from Australia, New Zealand, Ceylon, S. Africa and the Philippines (see Nierstrasz 1931). Haswell's (1881a) record of *Cymodocea pubescens* from S. Australia may well have been the female of *Cilicaea latreillei* (see p. 188) and his description of *Cilicaea classicaudata* agrees with males of this species (see also Stebbing 1905).

Paracilicaea hamata (Baker).

Cymodoce hamata Baker 1908.

Paracilicaea hamata (Baker) [Hale 1927, 1929, Nierstrasz 1931].

The genus *Paracilicaea* was erected by Stebbing (1910) and therefore does not appear in Hansen's (1906) key. One immature specimen (6 mm.) does, however, key out to this genus and species in Hale (1929) except that the two pairs of submedian tubercles on the abdomen and telson respectively are more prominent than is apparent in Hale (1929) and in the original description (Baker 1908). The species is reported to be fairly common amongst sponges in S. Australia (Hale 1929).

Paracilicaea septemdentata Baker.

Paracilicaea septemdentata Baker [Baker 1910, Hale 1929].

One male (6·0 mm.) and one damaged male specimen agree with this species, in which the dentition of the uropods and telson border are highly diagnostic (Baker 1910, Hale 1929).

Cymodopsis crassa Baker.

Cymodopsis crassa Baker [Baker 1926, Hale 1929].

One unsexed specimen (12·0 mm. body length) agrees very closely with the description of this new species and genus described by Baker (1926) and incorporated into a key by Hale (1929). Three additional small specimens (10·5, 5·0 and 5·0 mm.) also key out to the genus *Cymodopsis* (Hale 1929) and resemble *C. crassa* in having a pair of large conical bosses on the dorsal surface of the abdomen. However, unlike *C. crassa* which has a vestigial uropodal exopod, these three specimens have the exopod well developed. Whether this is characteristic of juvenile *C. crassa*, or whether the specimens belong to a different species, is worthy of further investigation with more material. The type material of *C. crassa* came from a depth of 6 fathoms in St. Vincent Gulf (Baker 1926).

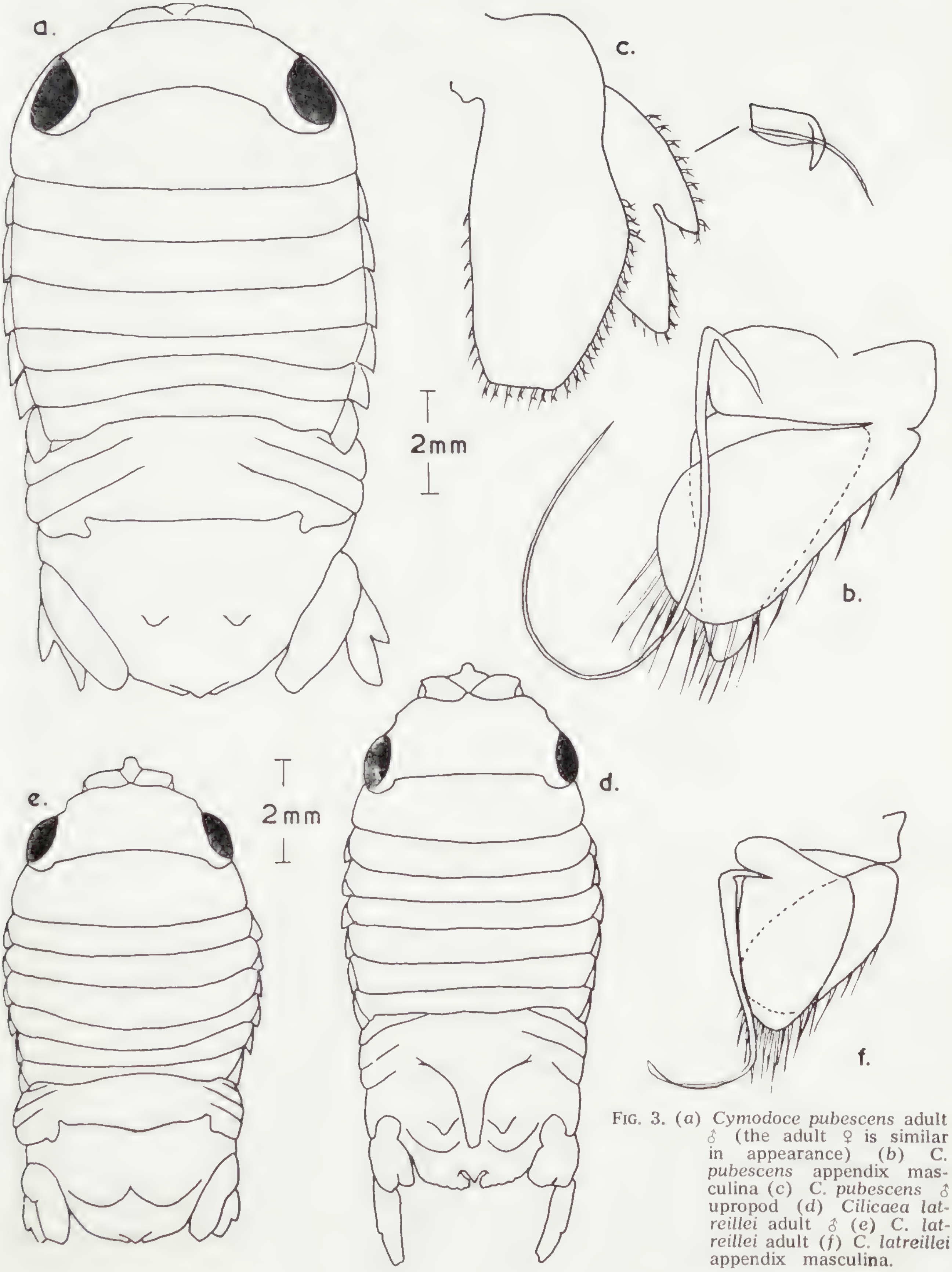

FIG. 3. (*a*) *Cymodoce pubescens* adult ♂ (the adult ♀ is similar in appearance) (*b*) *C. pubescens* appendix masculina (c) *C. pubescens* ♂ upropod (*d*) *Cilicaea latreillei* adult ♂ (*e*) *C. latreillei* adult (*f*) *C. latreillei* appendix masculina.

Group EUBRANCHIATAE.

Dynamenella parva Baker.

Dynamenella parva Baker [Baker 1928, Hale 1928, Nierstrasz 1931].

A single female (6·0 mm. body length) of this species does not key out to *Dynamenella* in Hansen (1906) owing to the relative smallness of the uropodal exopod, but it agrees closely with descriptions and figures of this species in that genus in Baker (1928) and Hale (1929).

Dynamenella rubida Baker.

Dynamenella rubida Baker, Baker 1926, Nierstrasz 1931.

One specimen (♂ 4·8 mm.) closely agrees with this species described by Baker (1926) in which the rami of the uropods are sub-equal and the appendix masculina of the present specimen just reaches the posterior border of pleopod 2. The present specimen is damaged but it is evident that a comparison of this species with *D. huttoni* from New Zealand would be worthwhile (see Naylor 1961).

Cerceis acuticaudata (Haswell).

Sphaeroma (?) *acuticaudata* Haswell (1881b).
Cerceis acuticaudata (Haswell) [Hansen 1905, Baker 1908, Hale 1929, Nierstrasz 1931].

Specimens key out to the genus *Cerceis* (Hansen 1906, Hale 1929) and agree with descriptions of this species in Haswell (1881b), Baker (1908) and Hale (1929). Differences between this species (Fig. 4a, b, c) and a similar form *C. tridentata* (see below and Fig. 4d, e) are given by Hale (1929). Present material of this common S. Australian species includes three males (14·8, 16·5 and 16·0 mm.), two females (14·0 and 19·2 mm.) and 6 juveniles (7·0, 7·4, 7·5, 9·1, 11·3 and 13·9 mm. body length).

Cerceis tridentata Milne Edwards.

Cerceis tridentata Milne Edwards [Milne Edwards 1840, Baker 1908, Hale 1929, Neirstrasz 1931].

Two males (each 14·0 mm. body length) key out to this species (Hansen 1906, Baker 1908, Hale 1929) which is very close to the previous one apart from the shape of the telson and uropods (see Fig. 4a, d).

Cerceis trispinosa (Haswell).

Cymodocea trispinosa Haswell 1881b.
Cerceis trispinosa (Haswell) [Baker 1910, Hale 1929].

One female (8·5 mm.) with oöstegites and modified mouthparts agrees with this species following Baker (1910) and Hale (1929). Haswell's (1881b) original description refers only to the male.

Haswellia anomala [= *emarginata*] (Haswell).

Sphaeroma (?) *anomala* Haswell 1881a.
Zuzara emarginata Haswell 1881b.
Haswellia emarginata (Haswell) [Hansen 1906, Hale 1929].
Haswellia anomala (Haswell) [Baker 1926].

Specimens key out to *Haswellia* (Hansen 1906, Hale 1929) and agree with descriptive notes and figures of this species in Haswell (1881a, b), Baker 1926 and Hale (1929). Haswell (1881a) described the female of this species first as *Sphaeroma* (?) *anomala*, a specific name which should perhaps take priority. The male was described later (Haswell 1881b), as *Zuzara emarginata*, a name which appears to be of more common usage.

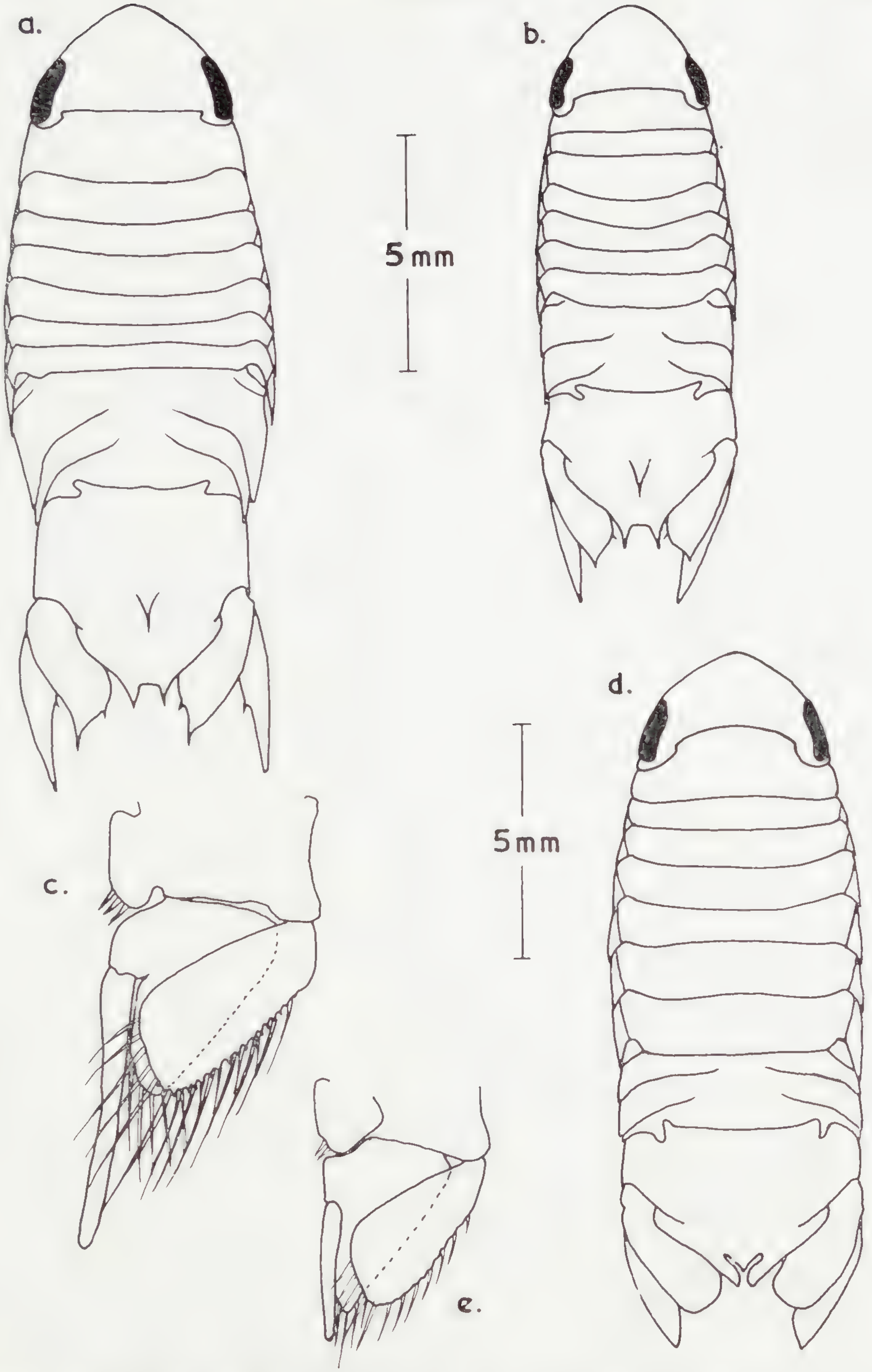

FIG. 4. (*a*) *Cerceis acuticaudata* adult ♂ (*b*) *C. acuticaudata* adult ♀ (*c*) *C. acuticaudata* appendix masculina (*d*) *Cerceis tridentata* adult ♀ (*e*) *C. tridentata* appendix masculina.

Baker (1926) pointed out that *H. anomala* is the female of another species of *Haswellia*, possibly *H. emarginata*, and Hale (1929) uses only the specific name *emarginata*, apparently for both. The species is common in the Port Phillip collections, males ranging up to 12 mm. and females up to 9 mm. body length.

DISTRIBUTION

Table 1 lists the sampling areas in Port Phillip Bay where one or more specimens of each species have been collected on one or more occasions, (see also Appendix). Of these species, *Paridotea munda*, *Cirolana woodjonesi*, *Crabyzos longicaudatus*, *Serolis tuberculata*, *Cymodoce multidens* var. *australis*, *Paracilicaea hamata* and *Cerceis trispinosa*, occurred only at stations well within the bay whilst *Eudotea peronii* *Neocirolana obesa*, *Zuzara venosa*, *Cymodoce bidentata*, *Paracilicaea septemdentata*, *Cymodopsis crassa* and *Dynamenella rubida* occurred only at the mouth of the bay. However, since many of these were recorded singly or as a few in only one area, it is difficult to be conclusive as to whether this reflects their true ecological distribution. The remaining species occurred more abundantly in the samples and mostly ranged into the bay from its mouth. Of particular interest amongst these is the relative distribution of the two most abundant species *Cilicaea latreillei* and *Cymodoce gaimardii* which tend to occur on the western and eastern sides of the bay, respectively (Fig. 5). Perhaps this is related to the fact

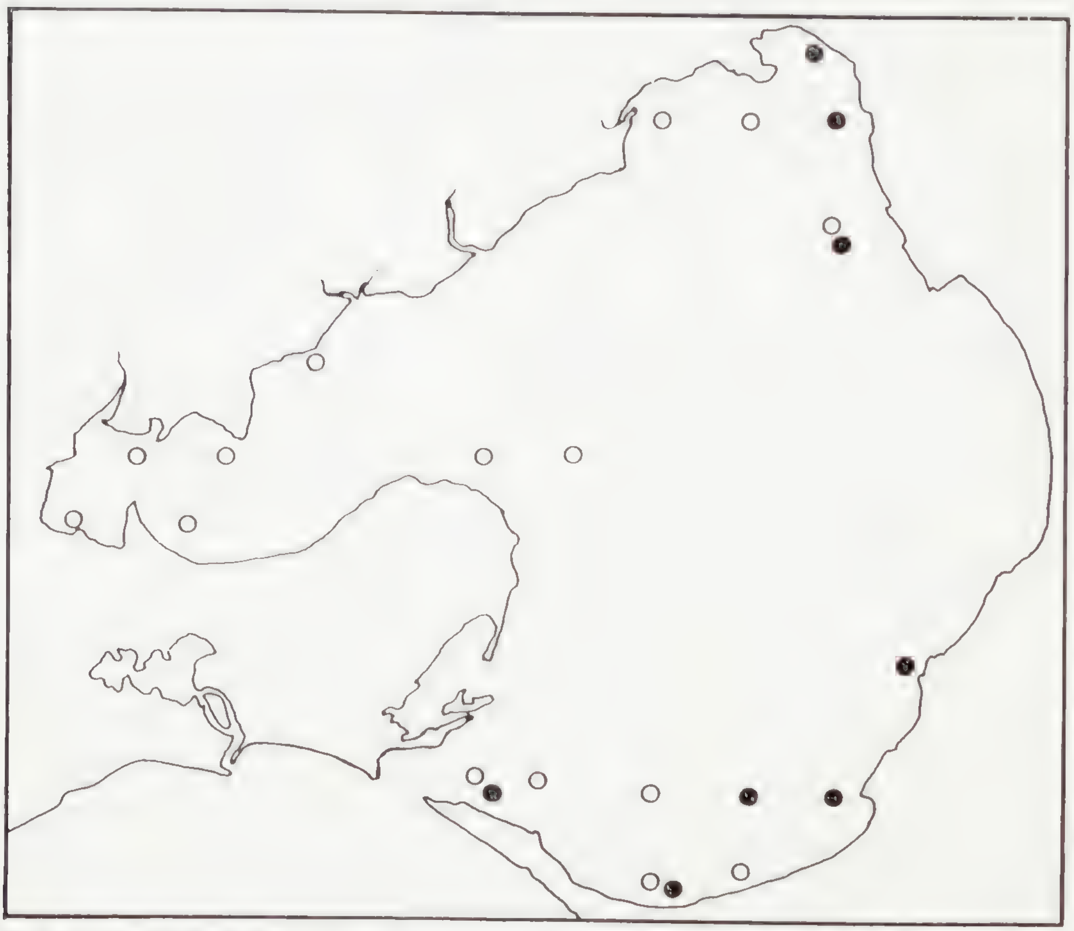

Fig. 5. Map of Port Phillip Bay showing the distribution of the most common species *Cymodoce gaimardii* (●) and *Cilicaea latrellei* (O).

that the north-western part of the bay has a clay or silt bottom whilst the south eastern portion is more sandy (A. Beasley and J. Hope Macpherson, personal communication). Amongst the other fairly common species no such clearly defined patterns of ecological distribution were apparent.

TABLE 1. AREAS AND STATIONS IN PORT PHILLIP BAY WHERE EACH SPECIES WAS COLLECTED.

Position of areas and stations are shown on Charts 1 and 2 (back of volume). Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171 Port Phillip with the numbered Area grid superimposed.

Chart 2 shows position of the stations numbered 1—317 with the same grid superimposed to aid in location of the stations and for correlation with depth &c. Localities in the text are shown as area number followed immediately by the station number in brackets. Table A (back of volume) records station number, date, area, method of collecting (dive or dredge) and depth in fathoms.

Species.	Areas and Stations where collected.
Paridotea munda	6 (118) 2 specimens; 42 (intertidal) 1 specimens; 55 (35) 1 specimen; 63 (16) 1 specimen.
Paridotea ungulata	5 (intertidal) 1 specimen; 10 (103–6) 1 specimen; 49 (236) 2 specimens; 58 (87) 1 specimen.
Crabyzos longicaudatus	5 (intertidal) 1 specimen.
Euidotea peronii	66 (291) 1 specimen.
Cirolana australiense	59 (36) 6 specimens; (150–2) 4 specimens; 61 (37) 8 specimens; 66 (291–2) 1 specimen.
Cirolana woodjonesi	5 (168) 1 specimen
Neocirolana obesa	39 (312–4) 1 specimen.
Serolis tuberculata	5 (—) 1 specimen.
Zuzara venosa	58 (—) 16 specimens.
Cymodoce bidentata	59 (79) 1 specimen.
Cymodoce coronata	11 (190, 192) 2 specimens; 28 (285) 1 specimen; 50 (233) 1 specimen; 59 (23) 1 specimen, (150–2) 2 specimens; 63 (18) 2 specimens; 68 (158) 1 specimen?
Cymodoce gaimardii	3 (202) 3 specimens, (203) 4 specimens; 7 (204–8) 6 specimens; 13 (82) 1 specimen, (93) 8 specimens; 55 (147) 6 specimens; 59 (87); 1 specimen, (150–2) 1 specimen; 62 (96) 2 specimens; 63 (18) 7 specimens; 68 (155) 1 specimen, (158) 7 specimens.
Cymodoce multidens var. *australis*	6 (65) 1 specimen.
Cymodoce pubescens	50 (233) 3 specimens; 51 (250) 1 specimen, (270) 2 specimens; 58 (80) 2 specimens.
Cymodoce tuberculosa	5 (54) 1 specimen; 26 (—) 2 specimens; 59 (214) 15 specimens.
Cilicaea curtispina	42 (38) 1 specimen; 58 (150–2) 1 specimen; 59 (36) 1 specimen.
Cilicaea latreillei	5 (54) 6 specimens; 6 (65) 1 specimen; 10 (103–6) 3 specimens; 13 (93) 1 specimen; 16 (142–3) 2 specimens; 26 (—) 4 specimens; 27 (138–9) 7 specimens; 30 (280) 1 specimen; 31 (130) 4 specimens; (132) 1 specimen; 37 (40) 1 specimen; 39 (46) 1 specimen; (312–4) 1 specimen; 59 (214) 5 specimens; 61 (241–2) 29 specimens; 68 (158) 1 specimen; 68 (158) 1 specimen; 69 (221–2) 1 specimen.
Paracilicaea hamata	55 (147) 1 specimen.

Table 1 etc.—*continued.*

Species.	Areas and Stations where collected.
Paracilicaea septemdentata	66 (291–2) 2 specimens.
Cymodopsis crassa	58 (80) 1 specimen.
Dynamenella parva	61 (37) 1 specimen.
Dynamenella rubida	58 (150–522) 1 specimen.
Cerceis acuticaudata	30 (278) 1 specimen; 220 specimens; 39 (46) (23) 1 specimen; 61 (37) 6 specimens. 1 specimen; 50 (233) 1 specimen; 59
Cerceis tridentata	61 (37) 2 specimens.
Cerceis trispinosa	30 (278) 1 specimen.
Haswellia anomala	31 (130) 4 specimens; 31 (132) 4 specimens; 55 (147) 1 specimen; 58 (80) 3 specimens; 59 (23) 8 specimens, (25) 2 specimens, (36) 4 specimens, (150–2) 13 specimens; 61 (37) 5 specimens.

Appendix: Details of Individual Collections from each Area.

(Numbers refer to areas and stations on Chart 2.)

Area and Station.	No. of Specimens.	Species.
3 (202)	3	*Cymodoce gaimardii*
3 (203)	4	*Cymodoce gaimardii*
5 (54)	6	*Cilicaea latreillei*
	1	*Cymodoce tuberculosa*
5 (168)	1	*Cirolana woodjonesi*
5 (—)	1	*Paridotea ungulata*
	1	*Crabyzos longicaudatus*
5 (—)	1	*Serolis tuberculata*
6 (65)	1	*Cilicaea latreillei*
	1	*Cymodoce multidens* var. *australis*
6 118)	2	*Paridotea munda*
7 (204–8)	6	*Cymodoce gairmardii*
10 (103–6)	3	*Cilicaea latreillei*
	1	*Paridotea ungulata*
11 (190, 192)	2	*Cymodoce coronata*
13 (82)	1	*Cymodoce gaimardii*
13 (93)	8	*Cymodoce gaimardii*
	1	*Cilicaea latreillei*
16 (142–3)	2	*Cilicaea latreillei*
26 (—)	2	*Cymodoce tuberculosa*
	4	*Cilicaea latreillei*
27 (138–9)	7	*Cilicaea latreillei*
28 (285)	1	*Cymodoce coronata*
30 (278)	1	*Cerceis acuticaudata*
	1	*Cerceis trispinosa*
30 (280)	3	*Cerceis acuticaudata*
	1	*Cilicaea latreillei*
31 (130)	4	*Cilicaea latreillei*
	4	*Haswellia anomala*
31 (132)	1	*Cilicaea latreillei*
	4	*Haswellia anomala*
37 (40)	1	*Cilicaea latreillei*
39 (46)	1	*Cilicaea latreillei*
	1	*Cerceis acuticaudata*
39 (312–4)	1	*Cilicaea latreillei*
	1	*Neocirolana obesa*
42 (intertidal)	1	*Paridotea munda*
42 (38)	1	*Cilicaea curtispina*
47 (26)	1	*Haswellia anomala*
49 (236–7)	2	*Paridotea ungulata*
50 (228)	1	*Cymodoce coronata*
50 (230)	1	*Cymodoce coronata*
50 (233)	1	*Cerceis acuticaudata*
	3	*Cymodoce pubescens*
	1	*Cymodoce coronata*

Appendix—Details etc.—*continued.*

Area and Station.	No. of Specimens.	Species.
51 (250)	1	*Cymodoce pubescens*
51 (270)	2	*Cymodoce pubescens*
55 (35)	1	*Paridotea munda*
55 (147)	1	*Haswellia anomala*
	6	*Cymodoce gaimardii*
	1	*Paracilicaea hamata*
58 (—)	16	*Zuzara venosa*
58 (80)	2	*Cymodoce pubescens*
	1	*Cymodopsis crassa*
	3	*Haswellia anomala*
58 (87)	1	*Paridotea ungulata*
58 (150–152)	7	*Haswellia anomala*
	1	*Cilicaea curtispina*
	1	*Dynamenella rubida*
59 (23)	1	*Cerceis acuticaudata*
	2	*Cilicaea latreillei*
	8	*Haswellia anomala*
59 (25)	2	*Haswellia anomala*
59 (36)	6	*Cirolana australiense*
	2	*Cilicaea latreillei*
	1	*Cilicaea curtispina*
	4	*Haswellia anomala*
59 (79)	2	*Cymodoce gaimardii*
	1	*Cymodoce bidentata*
59 (87)	1	*Cymodoce gaimardii*
59 (150–2)	1	*Cymodoce gaimardii*
	4	*Cirolana australiense*
	2	*Cymodoce coronata*
	13	*Haswellia anomala*
59 (214)	15	*Cymodoce tuberculosa*
	5	*Cilicaea latreillei*
61 (37)	2	*Cerceis tridentata*
	5	*Cerceis acuticaudata*
	8	*Cirolana australiense*
	5	*Haswellia anomala*
	1	*Dynamenalla parva*
61 (241–2)	29	*Cilicaea latreillei*
62 (96)	2	*Cymodoce gaimardii*
63 (16)	1	*Paridotea munda*
63 (18)	2	*Cymodoce coronata*
66 (291)	3	?*Cymodopsis crassa*
66 (291)	1	*Euidotea peronii*
66 (291–2)	1	*Cirolana australiense*
	2	*Paracilicaea septemdentata*
68 (155)	1	*Cymodoce gaimardii*
68 (158)	1	?*Cymodoce coronata*
	7	*Cymodoce gaimardii*
	1	*Cilicaea latreillei*
68 (Off Rye)	2	*Cilicaea latreillei*
69 (221–2)	1	*Cilicaea latreillei*

ACKNOWLEDGMENTS.

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PORT PHILLIP SURVEY 1957–1963.

BRACHIOPODA.

By J. Hope Macpherson,

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Family KRAUSSINIDAE.

Sub-family Megerliinae.

Megerlina lamarckiana Davidson.

Kraussia lamarckiana Davidson, 1852. Proc. Zool. Soc., p. 80, pl. 14, figs. 22–3.

MATERIAL: Port Phillip Survey: Area 55 (147).

REMARKS: Brachiopods were conspicuously absent from Port Phillip in contrast to Western Port Bay where several species are known to occur.

PORT PHILLIP SURVEY 1957–1963.

MOLLUSCA.

By *J. HOPE MACPHERSON*,

Curator of Molluscs—National Museum of Victoria.

SUMMARY.

The Mollusca, other than Opisthobranchs, collected during the survey are listed with records of distribution within Port Phillip and where clarification is considered necessary, descriptions are enlarged upon and nomenclature discussed. A list of species previously recorded from Port Phillip but not taken on the present survey is appended.

INTRODUCTION.

The shelled Mollusca have a greater attraction for the amateur zoologist than any other group of marine organisms and therefore are as a rule the best known member of any invertebrate fauna. This is very much the case in Victoria where settlement is comparatively recent and the number of professional zoologists has been limited.

Thus the components of the molluscan fauna are known but the ecology, anatomy and even the distribution of many species is still in need of study. The intention of the survey is to give information on the distribution and ecology of the species collected. The main body of the paper records the stations (see Charts I and II and Table A at back of volume) at which each species was taken and gives brief notes on the ecology and if necessary the nomenclature, and a description of the less well known species. None are new.

Species previously recorded from Port Phillip but not taken on the survey are listed with their place of collection. Many of these are minute and most records are from south of the Nepean Bay bar so were probably casual visitors from Bass Strait. A few early records from the northern end of Port Phillip suggest that pollution by a large bayside population may have proved too much for some species. Many such still occur in the comparatively unaffected waters of Western Port.

Most of the collecting of the survey was done in waters of greater depth than one fathom but it is intended to extend its scope as time permits to cover the littoral. This has already been commenced and collections have been made at a number of intertidal stations. Thus it was thought desirable to include the known littoral species in this account and so give as complete a review as possible of the molluscan fauna of Port Phillip.

Class **AMPHINEURA.**

Order **Lepidopleurida.**

Family LEPIDOPLEURIDAE.

Terinochiton liratus (A. Adams and Angas).

Lepidopleurus liratus A. Adams and Angas, 1864. Proc. Zool. Soc., p. 192.

Terenochiton liratus Iredale and Hull, 1925. Aust. Zool., III. (8), p. 342, pl. 39, f. 4.; 1927. Monograph p. 44, pl. 6, f. 4.

MATERIAL: Port Phillip Survey: Area 58 (293). Nat. Mus. Coll:—Port Phillip Heads (Area 58).

Order **Chitonida.**

Family Lepidochitonidae.

Subterenochiton gabrieli (Hull).

Ischnochiton gabrieli Hull, 1912. Proc. roy. Soc. Vic., 25, p. 120, pl. 8, f. 1a–f.

MATERIAL: Port Phillip Survey: Areas 55 (147), 13 (92).

Family Mopaliidae.

Poneroplax albida (Blainville).

Chiton albida Blainville, 1825. Dict. Sci. Nat. (Levrault) 36, p. 547.

Poneroplax albida Iredale and Hull, 1926. Aust. Zool., IV. (3) p. 165, 2 text. fig., pl. 18, f. 1, 9, 10.

MATERIAL: Port Phillip Survey: Areas 55 (intertidal).

REMARKS: This is a common species of the lower littoral on rock platforms where it occurs on exposed surfaces in the "bare" zone of Bennett and Pope. Although an inhabitant of exposed ocean platforms it penetrates as far north in Port Phillip as Ricketts Point (Area 23).

Poneroplax costata (Blainville).

Chiton costatus Blainville, 1825. Dict. Sci. Nat. (Levrault) 36, p. 548.

Poneroplax costata Iredale and Hull, 1926. Aust. Zool. IV., (3) p. 165 text figs., pl. 18, f. 1, 9 and 10.

MATERIAL: Port Phillip Survey: Areas 55 (39); S. side Schnapper Point.

REMARKS: Of similar habitat to the previous species and occurring with it in Port Phillip.

Kopionella matthewsi (Iredale).

Plaxiphora matthewsi Iredale, 1910. Proc. Mal. Soc., 9, p. 99. Iredale and May, 1916. ibid. XII., p. 101, pl. 5, f. 4, $4a^{ii}$, $4a^{iii}$.

MATERIAL: Port Phillip Survey: Areas 42 (38); Nat. Mus. Coll.: Mornington (Area 55).

Family Cryptoplacidae.

Craspedoplax variabilis (H. Adams and Angas).

Hanleya variabilis H. Adams and Angas, 1864, p. 194, pl. 6, f. 3.

MATERIAL: Port Phillip Survey: Areas 48 (34); Nat. Mus. Coll.: Mornington (Area 55), Barwon Heads (Area 56).

Acanthochiton bednalli (Pilsbry).

Acanthochites bednalli Pilsbry, 1894. Proc. Acad. Nat. Sci. Philad., p. 81, pl. 2, f. 7–11.

MATERIAL: Port Phillip Survey: Area 42 (38); Nat. Mus. Coll.: Port Phillip Heads (Area 58).

Acanthochiton granostriatus (Pilsbry).

Acanthochites granostriatus Pilsbry, 1894. Nautilus, 8, p. 119; Proc. Acad. Nat. Sci. Philad., p. 81, pl. 2, f. 1–6; pl. 4, f. 37.

MATERIAL: Port Phillip Survey: Areas 55 (39); Gatliff Coll.: Black Rock (Area 14), Sandringham (Area 13).

Meturoplax retrojecta (Pilsbry).

Acanthochites retrojecta Pilsbry, 1894. Nautilus 7, p. 107.

Meturoplax retrojectus Iredale and Hull, 1925. Aust. Zool., IV. (2) p. 89, pl. 10, f. 26–30.

MATERIAL: Port Phillip Survey: Areas 13 (93, 94); 14 (95); 36 (77); 28 (285); 30 (280).

REMARKS: This is a cryptic reef dwelling species which occurs in suitable sheltered positions such as amongst *Galeolaria* or algae from the lower littoral to several fathoms.

Cryptoplax iredalei Ashby.

Cryptoplax iredalei Ashby, 1923. Trans. roy. Soc. S. Aust., 47, p. 238, pl. 19, f. 4.

MATERIAL: Port Phillip Survey: Areas 59 (36); 66 (292); 58 (293).

Cryptoplax striata (Lamarck).

Chitonellus striatus Lamarck, 1819. Anim. s. Vert. 6, p. 317.

Cryptoplax striata Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 13, f. 21.

MATERIAL: Port Phillip Survey: Area 61 (239).

Family ISCHNOCHITONIDAE.

Ischnochiton elongatus (Blainville).

Chiton elongatus Blainville, 1825. Dict. Sci. Nat. (Levrault), 36, p. 542.

Ischnochiton elongatus Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 14, f. 22.

MATERIAL: Port Phillip Survey: Area 55 (39); (Sunnyside beach intertidal); 13 (93, 94); 14 (95); 5 (53–4); 27 (41); 17 (170); 6 (137); 55 S. side of Schnapper Point; 30 (280); 63 (163).

Ischnochiton falcatus Hull.

Ischnochiton falcatus Hull, 1912. Proc. roy. Soc. Vict. 25, p. 121, pl. VIII.

MATERIAL: Port Phillip Survey: Areas 50 (230).

Ischnochiton lineolata.

Chiton lineolatus Blainville, 1825. Dict. Sci. Nat. (Levrault), 36, p. 541.

Ischnochiton lineolatus Macpherson and Gabriel, 1962. Marine Molluscs of Victoria p. 14, f. 23.

MATERIAL: Port Phillip Survey: Area 42 (38).

Ischnochiton variegata (H. Adams and Angas).

Lepidopleurus variegatus H. Adams and Angas, 1864. *Proc. Zool. Soc. Lond.* 1864, p. 192.

Ischnochiton atkinsoni Iredale and May, 1916. *Proc. Mal. Soc. Lond.*, XII., p. 110, pl. IV., f. 3.

Ischnochiton atkinsoni lincolnensis Ashby, 1920. Trans. roy. Soc. S. Aust., 44, p. 275, pl. XII., f. 5a, 5b.

Ischnochiton variegatus Iredale and Hull, 1927. *A Monograph of Aust. Loricates* p. 13, pl. 1, f. 2.

Ischnochiton atkinsoni, ibid. p. 20, pl. II., f. 33a, 33b.

MATERIAL: Port Phillip Survey: Areas 42 (38); 55 (intertidal S. side of Schnapper Point), 37 (40).

REMARKS: This is a variable species and there has been considerable confusion amongst authors in regard to its determination. Adams and Angas originally applied the name *variabilis* to specimens from

Yorke Peninsula, S. Australia and Iredale and May named the Tasmanian representative *atkinsoni*. Ashby considered some S. Australian and Victorian specimens to be distinct from *variegatus* and closer to the Tasmanian *atkinsoni* of which he made them a subspecies calling it *lincolnensis*.

Iredale and Hull disagreed with this and put *lincolnensis* into the synonomy of *variegata*. They still retained *atkinsoni* and distinguished between it and *variegata* by the size of girdle scales and number of slits, in *variegata* and in *atkinsoni*. As the Port Phillip material proved difficult to place satisfactorily the whole group came under review. The girdle scales were measured with a micrometer eye piece and in all three so called species were approximately the same size.

Three specimens from each of the type localities were examined to determine the formation for the slits and it was found that the number in the anterior valve varied between 9–12, and in the posterior between 9–13. Usually the number of slits in the anterior and posterior valves is the same but not always.

Heterozona cariosa (Dall).

Heterozona cariosa Dall, 1892. In Pilsbry Man. Conch., XIV., p. 66, pl. 24, f. 23.

MATERIAL: Port Phillip Survey: Areas 55 (Sunnyside beach intertidal); 13 (93, 94); 14 (95); 27 (41); 17 (170); 42 (38, 281); 28 (285); 16 (143). Nat. Mus. Coll.: Port Phillip Heads (Area 58).

Heterozona fruticosa (Gould).

Ischnochiton fruticosa Gould, 1846. Proc. Boston Nat. Hist. Soc., 11, p. 142; Dall, 1892 in Pilsbry Man. Conch., XIV., p. 91, pl. 23, f. 78–80.

MATERIAL: Port Phillip Survey: Area 5 (53–4).

Ischnoradsia evanida (Sowerby).

Chiton evanidus Sowerby, 1840. Mag. Nat. Hist., (Charlesworth), IV., p. 291; Conch. Illust. (Chiton) 1840 f. 139.

MATERIAL: Port Phillip Survey: Areas 55 (S. side Schnapper Point).

REMARKS: This is a sublittoral species living under stones and so was not collected on the present phase of the survey, though it is known to be common in Port Phillip.

Aulocochiton cimolia (Reeve).

Chiton cimolia Reeve, 1847. Conch. Icon 4, pl. 21, f. 141.

MATERIAL: Port Phillip Survey: Area 36 (76) Nat. Mus. Coll.: Williamstown (Area 6).

Rhyssoplax tricostalis (Pilsbry).

Chiton tricostales Pilsbry, 1894. Nautilus VIII., p. 54.

Rhyssoplax tricostalis Macpherson and Gabriel, 1962. Marine Molluscs of Victoria p. 25, f. 37.

MATERIAL: Port Phillip Survey: Areas 13 (93, 94); 14 (95); 6 (65); 59 (36); 55 (147); 31 (10); 6 (137); 66 (292); 42 (281). Nat. Mus. Coll.: Port Phillip Heads (Area 58).

Family CHITONIDAE.

Rhyssoplax exoptanda Bednall.

Chiton bednalli Pilsbry, 1895. Nautilus 9, p. 90; Bednall, 1897. Proc. Mal. Soc. Lond., II., No. 4, p. 153, text. fig. and pl. 12, f. 8.

MATERIAL: Port Phillip Survey: Area 14 (175).

Class **GASTROPODA.**

Family HALIOTIDAE.

Notohaliotis ruber (Leach).

Haliotis ruber Leach, 1814. Zool. Misc., 1, p. 54, pl. 23.

MATERIAL: Port Phillip Survey: Areas 6 (137); 13 (93); 14 (175); 17 (172); 27 (41); 30 (10, 135); 31 (132); 55 (intertidal); 58 (150–2); 59 (24, 36, 79, 81); 61 (37); 63 (163); 64 (166). Nat. Mus. Coll.: Hobson's Bay (Areas 2 and 3), Geelong (Area 37–8); Brighton (Area 7); Beaumaris (Area 14); Mornington (Area 55); Mordialloc (Area 24); Point Lonsdale (Area 58); R. Burn Coll.: Portarlington (Area 29); Ocean Beach, Rye (Area 67).

REMARKS: This is the commonest and most widespread species of Haliotidae in south-eastern Australia, it occurs abundantly both in bays and on the open coast wherever reefs provide a suitable substratum for its attachment. In September, 1960, at stations 10 and 135 there was one adult specimen every two yards ranging in depths from 8 to 40 feet. Other reefs such as off Mornington (Area 55) and Pope's Eye (station 36) also carried dense populations.

Since the completion of this survey large scale commercial fishing of *Haliotidae* is being carried out and the Fisheries and Wildlife Department have supplied the following figures of the catch for 1964–65. Flesh weight of 68,088 lb. and shell weight of 204,267 lb.

Marinauris emmae (Reeve).

Haliotis emmae Reeve, 1846. Conch. Icon., 3, pl. 10, f. 29.

MATERIAL: Port Phillip Survey: Areas 58 (150–2); 64 (164); R. Burn Coll.: Portarlington (Area 29); Nat. Mus. Coll. Queenscliff (Area 58).

REMARKS: This is not a very common species in Victorian waters and the only two records in the present survey indicate that it favours open but sheltered water ranging in depth from 10 to 20 feet. As the substratum of the two localities is quite different, stations 150–2 being dune limestone and 164 granite, it would seem that it is hydrological conditions rather than type of rock that is the limiting factor in distribution.

It is not recorded further east than Western Port in Victoria.

Schismotis laevigata (Donovan).

Haliotis laevigatus Donovan, 1808. Rees Encyclopaedia, Conch. Series, pl. 6.

MATERIAL: Port Phillip Survey: Areas 30 (10, 135); 42 (38); 58 (150); 59 (23, 24, 36). Nat. Mus. Coll.: Hobson's Bay (Areas 2 and 3).

REMARKS: This species like *M. emmae* is at the end of its range eastward and is selective in habitat, selection seems to be based, as in that species, more on hydrological conditions than on substratum.

This species is fished commercially but, because of its comparative scarcity in Victorian waters, forms only a small proportion of the commercial fishery.

Family FISSURELLIDAE.

Notomella candida (A. Adams).

Emarginula candida A. Adams, 1851. Proc. Zool. Soc. p. 85, No. 30; Reeve, 1873. Conch. Icon. vol. XIX., pl. 7, f. 45.

MATERIAL: Port Phillip Survey: Areas 13 (94); 55 (39, 149); 59 (36); Nat. Mus. Coll.: Port Phillip Heads (Area 58).

REMARKS: There has been some confusion as to the correct nomenclature for the common members of the genus *Notomella* in southern Australia. In order to clarify the matter specimens of the so called species *Emarginula candida* and *E. dilecta* A. Adams were sent to the British Museum for comparison with the type material. Mr. S. P. Dance's comments were as follows:

> " *Emarginula candida* A. Adams, 1851. The only specimens you have sent which match the type species of this species are those in lot F25270 (Port Phillip Heads). Those in lot F25271 (Port Jackson, N.S.W.) may come within the range of variability of the species but you are in the best position to judge this.
>
> *Emarginula dilecta* A. Adams, 1851. None of your species matches the type series of this species. I believe that this name must be deleted from the southern Australian list, however, for the following reason. The only well-localized lot in our collection which does match the type series is from Bombay. Other specimens in our collection labelled *dilecta* are quite unlike the types and I conclude therefore, that Adam's locality for the species given with the original description is erroneous. This would not be the first time that Adams gave a wrong locality for a species ".

In regard to *E. candida*, as the present paper is not concerned with material other than from Port Phillip it seems best to leave discussion on the relationship of the Victorian and N. S. Wales forms until detailed examination of the animals can be carried out. The N. S. Wales form has already been separated from the South Australian shells as *N. hedleyi* Thiele.

Mr. Dance's comment on *E. dilecta* confirm the conclusions reached by Hedley (Proc. Linn. Soc. N. S. Wales, 28, 1913, p. 276; ibid., 48, 1923, p. 307) and as the same species appears to extend from N. S. Wales to Western Australia Hedley's name *bajula* will replace *dilecta* in the literature of this species.

Montfortula rugosa (Quoy and Gaimard).

Emarginula rugosa Quoy and Gaimard, 1834. Voy. " *Astrolabe* " Zool. 3., p. 331, pl. 68, f. 17–18.

MATERIAL: Port Phillip Survey: Areas 55 (intertidal); 59 (36); 42 (38, 108); Nat. Mus. Coll.: Sandringham (Area 13–4).

REMARKS: This is a shallow water species whose habitat is in shelter at and below low tide mark. It is common where *Galeolaria* and algae afford maximum shelter and so was only taken on the present survey at stations in very shallow water. However, it is known to be common on suitable rock platforms throughout the southern half of Port Phillip.

Amblychilepas javanicensis (Lamarck).

Fissurella javanicensis Lamarck, 1822. Anim. s. Vert., 6 (2), p. 14; Delessert 1841, *Recuiel. Coquilles* pl. 24, f. a. b. c.

MATERIAL: Port Phillip Survey: Area 66 (292). Pritchard and Gatliff Coll.: Portsea and Sorrento (Area 58–9); Nat. Mus. Coll. Dromana (Area 63–70).

REMARKS: This species lives in sand in open but sheltered water in depths from low water to at least 10 fathoms and on the present survey was not taken inside Port Phillip Heads.

Amblychilepas omicron (Crosse and Fischer).

Fissurella omicron Crosse and Fischer, 1864. Journ. de Conch., 12, p. 348; ibid. 13, p. 41, pl. 3, f. 4–6.

MATERIAL: Port Phillip Survey: Areas 59 (23); Gatliff Coll.: Portsea (Area 58–9).

REMARKS: This species lives amongst algae on rock platforms in shallow water. It seems to require sheltered but clear water and has not been taken north of Portsea.

Amblychilepas nigrita (Sowerby).

Fissurella nigrita Sowerby, 1834. Proc. Zool. Soc., p. 127; Sowerby 1835, *Conch. Ill.*, p. 6, No. 51, f. 47.

MATERIAL: Port Phillip: 42 (38); 64 (164).

REMARKS: This and the following species occur in shallow water under stones in bays and inlets that give sheltered clear water but it does not penetrate into the north half of Port Phillip.

Amblychilepas oblonga (Menke).

Fissurella oblonga Menke, 1834. P. 33.

Lucapinella pritchardi Hedley, 1895. *Proc. roy. Soc. Vic.* VII. (n.s.), pp. 198–9, pl. II., f. 3–7.

MATERIAL: Port Phillip: Area 64 (164); Gatliff Coll.: Port Phillip; Nat. Mus. Coll.: Brighton (Area 7).

REMARKS: Occurs under similar conditions to the species above.

Cosmetalolepas concatenatus (Crosse and Fischer).

Fissurella concatenata Crosse and Fischer, 1864. Journ. de Conch. 12, p. 348, pl. 3, f. 4–6.

MATERIAL: Port Phillip Survey: Area 59 (36); Gatliff Coll.: Port Phillip uncommon.

REMARKS: This species occurs under stones and in clear, shallow water, such a habitat is found within the perimeter of Pope's Eye Annulus (Station 36), the only station at which it was taken in the present survey.

Eligidion audax (Iredale).

Eligidion audax Iredale, 1924. *Proc. Linn. Soc. N. S. Wales*, 49, p. 220, pl. 35, f.5–6.

Fissurella lineata Hedley, 1900 (non Sowerby), ibid., 25 pt. 1, p. 95, pl. 3, f. 11, animal.

MATERIAL: Port Phillip Survey: Area 14 (175; off shore Ricketts Point); 30 (130); 31 (10); 55 (147, off Schnapper Point). Gatliff Coll.: Sandringham (Area 13–14), Mornington (Area 55), Sorrento (Area 59). Nat. Mus. Coll.: Williamstown (Area 6), Hobson's Bay (Areas 2 and 3), Mordialloc (Area 55).

REMARKS: This large keyhole limpet is common from shallow water (1 or 2 fathoms) to depth of 25 fathoms or more where reefs afford it a suitable substratum. In Port Phillip it is confined to the more open water

of the south eastern half of the bay where it is common on the platforms. In Bass Strait it has been dredged at 25 fathoms. The Isopod *Cymodoce gaimardii* has a similar distribution (see Naylor 1966, Mem. nat. Mus. Vict. No. 27, p. 194).

Family PATELLIDAE.

Cellana tramoserica (Sowerby).

Patella tramoserica Sowerby, 1825. Cat. Tankerville Coll.: p. 30; Reeve 1854, *Conc. Icon.* VIII., pl. 13, f. 27a.

MATERIAL: Port Phillip Survey: Areas 55 (intertidal); 59 (36, 81). Nat. Mus. Coll.: Portsea (Area 58–9); Mornington (Area 55); Brighton (Area 7).

REMARKS: This is an intertidal rock dwelling species common on the open coast of south eastern mainland Australia from Southern Queensland to South Australia. It also penetrates bays where the salinity approximates ocean water and is common on intertidal platforms, even in Hobson's Bay at the northern end of Port Phillip.

Family ACMAEIDAE.

Patelloida alticostata (Angas).

Patelloida alticostata Angas, 1856. Proc. Zool. Soc., p. 56, pl. 2, f. 11.

MATERIAL: Port Phillip Survey: Areas 6 (118); 42 (38); 48 (34); 55 (jetty); 61 (37). Nat. Mus. Coll.: Hobson's Bay (Area 2 and 3); Williamstown (Area 6); Brighton (Area 7); Mornington (Area 55); Dromana (Area 63, 76); Portsea (Area 58–9).

REMARKS: This species like *Cellana tramoserica* is an inhabitant of open coast rock platforms at midtide level and occurs throughout the entire southerly Australian coast line from Geraldton, W. Australia to southern Queensland. It is found on reefs throughout Port Phillip.

Chiazacmea flammae (Quoy and Gaimard).

Patelloida flammae Quoy and Gaimard, 1834. Voy. "*Astrolabe*" Zool., 3, p. 354, pl. 71, f. 15, 16.

MATERIAL: Port Phillip Survey: Areas 55 (intertidal) 59 (23); Williamstown (Area 6); St. Kilda (Area 3, 7). Nat. Mus. Coll.:

REMARKS: An intertidal species of the lower littoral of sheltered platforms, it has a limited distribution in Port Phillip.

Actinoleuca calamus (Crosse and Fischer).

Patella calamus Crosse and Fischer, 1864. Journ. de Conch., p. 348; ibid. 1865, p. 42, pl. 3, f. 7, 8.

MATERIAL: Port Phillip Survey: Areas 5 (53, 56); 6 (65, 137); 7 (206); 10 (11); 11 (190); 13 (92–3); 14 (95, 175); 15 (284); 17 (173); 18 (59); 28 (285); 30 (130); 31 (10); 36 (77); 37 (40); 55 (39, 147); 62 (96, 99); 69 (97). Nat. Mus. Coll.: Rye (Area 68).

REMARKS: Occurs throughout the bay in localities which have bottom sediments of the sandy mud range and depths of less than 9 fathoms. In spite of its preference for areas of finer sediments it requires a hard substrate for attachment and so only occurs where reefs, pebbles or shell afford such a surface.

Notoacmea granosa (Macpherson).

Notoacmea granosa Macpherson, 1954. Proc. roy. Soc. Vict., 67, p. 252–3, pl. XVII., f. 3–4, text figs.

MATERIAL: Port Phillip Survey: Area 55 (S side of Schnapper Pt.). Nat. Mus. Coll.: Sandringham (Area 13–14); Mornington (Area 55).

REMARKS: Occurs on the sheltered side of vertical rock faces at mid-tide level on open coasts and penetrates Port Phillip as far north as Altona Pier.

Notoacmea mayi (May).

Notoacmea mayi May, 1923. Illust. Index. Tas. Shells, Append. and pl. 22, f. 3.

MATERIAL: Port Phillip Survey: Area 42 (108); Gatliff Coll.: Port Phillip.

REMARKS: The single specimen of this open ocean species was found attached to the rocks in about five feet of water.

Notoacmea scabrilirata (Angas).

Acmea scabrilirata Angas, 1865. Proc. Zool. Soc., p. 154.

MATERIAL: Port Phillip Survey: Areas 55 intertidal. Nat. Mus. Coll.: Hobson's Bay (Area 2 and 3).

REMARKS: This species lives on open coasts under stones at low tide and is taken in similar positions in Port Phillip.

Family TROCHIDAE.

Herpetopoma aspersa (Philippi).

Trochus aspersus Philippi, 1846. Zeitchr fur Malak., III., p. 103; Conch. Cab. 1846, Bd. II., p. 173, t. 27, f. 13.

MATERIAL: Port Phillip Survey: Area 55 (147); 63 (163). Nat. Mus. Coll.: Brighton (Area 7).

REMARKS: This species ranges from low tide under stones to several fathoms but is more abundant in the warmer waters of the eastern part of Victoria.

Granata imbricata (Lamarck).

Stomatella imbricata Lamarck, 1822. Anim. s. Vert., 6 (2), p. 209. Reeve, 1874, Conch. Icon. XIX., pl. 2, f. 10

MATERIAL: Nat. Mus. Coll: Brighton (Area 7); Frankston (Area 48).

REMARKS: Lamarck, when he listed the members of the genus *Stomatella* put *imbricata* as the first species on his list and most authors have accepted it as the type species of the genus. However, Cotton 1957, pointed out that Anton 1839 designated *Stomatella auriculata* Lamarck, 1816, as the type species of *Stomatella* and erected *Granata* with *S. imbricata* as type species to replace it. Macpherson and Gabriel 1962 disagreed with this on the grounds that *imbricata* had line priority in Anton's text, however they had failed to note that Anton in his foreword stated "so bei den Gattungen (deren Typusart mit Versalbuchstaben gebruckt ist)". Thus Cotton was correct *Stomatella auriculata* Lamarck 1816 had been designated the type of *Stomatella* and it therefore must replace *Gena* Gray 1847, and *Granata* used in its stead for the *S. imbricata* series.

This species was not taken on the present survey because of the lack of collecting in the intertidal zone but previous records show it will probably occur when collecting is extended to the littoral.

Calliostoma (Fautor) allporti (Tenison Woods).

Zizyphinus allporti Tenison Woods, 1875. Proc. roy. Soc. Tas., p. 155.

Calliostoma (Fautor) allporti Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 57, f. 76.

MATERIAL: Port Phillip Survey: Areas 59 (36).

Cantharidella tiberiana (Crosse).

Trochus tiberiana Crosse, 1863. Journ. de Conch. 11, p. 381, pl. 13, f. 2.

MATERIAL: Port Phillip Survey: Areas 14 (95); 15 (284); 16 (143); 27 (41); 30 (130, 280); 31 (131); 39 (42–3, 313); 40 (101); 42 (281); 48 (34); 50 (238); 58 (88); 59 (25, 36). Gabriel Coll. off Point Cook (Area 5); Nat. Mus. Coll.: Corio Bay (Areas 25, 37–8); Hobsons Bay (Areas 2–3). R. Burn Coll.: Portarlington (Area 29).

REMARKS: Living on weed and confined to the *Caulerpa* and *Zostera* beds where it is associated with *Diala monile* and *D. lauta*.

Cantharidus pulcherrimus (Wood).

Trochus pulcherrimus Wood, 1828. Index Test. Suppl., p. 18, pl. 6, f. 45

MATERIAL: Port Phillip Survey: Areas 56 (295); 58 (88, 151). Gabriel Coll.: Point Nepean, Queenscliff (Area 58). Nat. Mus. Coll.: Brighton (Area 7); Point Lonsdale (Area 58).

REMARKS: A weed dwelling species which seems to be confined now to the rich algal beds around Port Phillip Heads.

Cantharidus ramburi (Crosse).

Trochus ramburi Crosse, 1864. Joorn. de Conch., p. 342, pl. 13, f. 3.

MATERIAL: Port Phillip Survey: Area 66 (292); Gabriel Coll.: Point Nepean (Area 38); Portsea (Area 58–9); Point Lonsdale (Area 58). Nat. Mus. Coll: Queenscliff (Area 58).

REMARKS: This species is found in similar locations to the previous one.

Phasianotrochus apicinus (Menke).

Monodonta apicina Menke, 1843, Moll. Nov. Holl., p. 15.

Trochus apicinus Philippi, 1846. Conch. Cab., p. 133, pl. 23, f. 5.

MATERIAL: Port Phillip Survey: Area 59 (23); (36); 58 (88); 68 (155); 50 (230); 51 (250); 30 (280); 42 (281); 42 (intertidal); R. Burn Coll: Portarlington (Area 29).

REMARKS: A weed dwelling species that is common on the algal beds of the south-western shore of the bay. Members of this genus seem to favour more sheltered conditions than *Cantharidus* s.s. and all the species recorded occur north of the Nepean bar in deeper water. It is interesting to note that because of lack of collecting except in the intertidal zones, previous records from Port Phillip are very sparse or non-existant.

Phasianotrochus eximius (Perry).

Bulimus eximius Perry, 1811. Conch., pl. 30, f. 2.

MATERIAL: Port Phillip Survey: Areas 27 (41); Gabriel Coll.: Point Nepean, Point Lonsdale (Area 58).

REMARKS: This weed dwelling species has a wide distribution in southern Australia.

Phasianotrochus irisodontes (Quoy and Gaimard).

Trochus irisodontes Quoy and Gaimard, 1834. Voy. "*Astrolabe*" Zool., 3, p. 246, pl. 63, f. 1–2.

MATERIAL: Port Phillip Survey: Areas 27 (41). R. Burn Coll: Portarlington (Area 29).

Phasianotrochus rutilus (A. Adams).

Elenchas rutilus A. Adams, 1851. Proc. Zool. Soc., p. 171.

Cantharidus rutilus Tryon, 1889. Man. Conch. XI.; p. 136, pl. 34, f. 8.

MATERIAL: Port Phillip Survey: Areas 5 (54); 10 (14–5); 50 (230–1).

Austrocochlea adelaidea (Philippi).

Trochus adelaidea Philippi, 1849. Conch. Cab., 2, p. 140, pl. 24, f. 1.

MATERIAL: Port Phillip Survey: Area 59 (23, 80). Nat. Mus. Coll.: Sorrento (Area 59).

REMARKS: This species is not so tolerant of silt as other Victorian members of the genus and is confined to areas south of the Nepean bar.

Austrocochlea constricta (Lamarck).

Monodonta constricta Lamarck, 1822. Anim. s. Vert. 7, p. 36.

Trochus constrictus Quoy and Gaimard, 1834. Voy. "*Austrolabe*", Zool., 3, p. 251, pl. 63, f. 23–27.

MATERIAL: Port Phillip Survey: Areas 42 (38); 38 (89); 49 (236). Nat. Mus. Coll.: Sorrento (Area 59), Brighton (Area 7); Hobsons Bay (Area 2 and 3); St. Kilda (Area 3); R. Burn Coll: Point Lonsdale (Area 58).

REMARKS: This species has a wide tolerance of habitat and salinity and occurs from the open coast to the extreme northern end of the bay where specimens become more stunted in the less favourable conditions.

Austrocochlea odontis (Wood).

Trochus odontis Wood, 1828. Index. Text. Supp., p. 17, pl. 6, f. 37.

MATERIAL: Port Phillip Survey: 42 (38, intertidal); 59 (23). Nat. Mus. Coll.: Hobsons Bay (Areas 2–3).

REMARKS: This weed dwelling species is like *A. constricta* able to tolerate a wide range of conditions.

Clanculus (Euriclanculus) aloysii (Tenison Woods).

Clanculus aloysii Tenison Woods, 1875. Proc. roy. Soc. Tas., p. 155.

Trochus (Clanculus) aloysii Tryon, 1889. Mar. Conch. XI., p. 59, pl. 14, f. 20–23.

MATERIAL: Port Phillip Survey: Areas 5 (52–4); 6 (137); 7 (206); 9 (178, 180); 10 (13–5); 11 (190); 13 (83, 92–3); 14 (117); 15 (284); 16 (143); 18 (59); 19 (179, 181); 27 (41); 28 (285); 30 (130); 31 (10); 34 (120); 36 (77); 37 (40); 40 (101); 42 (108); 50 (228, 230); 55 (147); 59 (25, 213); 68 (155). R. Burn Coll.: Portarlington (Area 29).

REMARKS: This species is confined to the finer sediments from low tide to approximately seven fathoms but only where dead shells, stones or reef provide it with a solid surface to which to attach itself. Its presence at station 120 within the 10 fathom line indicates that it is the availability of a hard surface for attachment rather than depth that limits the distribution.

Clanculus (Mesoclanculus) plebejus (Philippi).

Trochus plebejus Philippi, 1851. Zeits. f. Malak., 8, p. 41; Conch. Cob., p. 326, pl. 46, f. 10.

MATERIAL: Port Phillip Survey: Areas 5 (52–4); 6 (137); 7 (206); 9 (178, 180); 10 (15); 11 (190); 13 (92); 14 (117, 175); 15 (284); 16 (143); 17 (173); 18 (59); 19 (179, 181); 27 (41); 28 (141–2, 285); 30 (130, 135); 31 (10); 37 (40); 39 (313); 40 (101); 42 (108, intertidal); 50 (228, 230–1, 238); 55 (S. of Schnapper Pt. intertidal); 59 (25, 36); 63 (163); 68 (155). Nat. Mus. Coll.: Portarlington (Area 29), Brighton (Area 7); Hobsons Bay (Area 2–3).

REMARKS: Is common under stones just below low tide and also in deeper water where there are suitable solid objects for attachment. This species is very often associated with the previous species *C. aloysii* in the deeper parts of its range.

Clanculus (Euriclanculus) limbatus (Quoy and Gaimard).

Trochus limbatus Quoy and Gaimard, 1834. Voy. "Astrolabe" Zool., 3, p. 245, pl. 63 f. 1–6

MATERIAL: Port Phillip Survey: Area 16 (143). Nat. Mus. Coll.: Mornington (Area 55).

REMARKS: An uncommon species within Port Phillip.

Ethminiola tasmanica (Tenison Woods).

Margarita (Monolia) tasmanica Tenison Woods, 1877. Proc. roy. Soc. Tas., p. 143, No. 33.

Minolia tasmanica Tryon, 1889. Man. Conch. XI., p. 263, pl. 61, f. 38–40.

MATERIAL: Port Phillip Survey: Areas 13 (94); 18 (59); 24 (122); 36 (77). R. Burn. Coll.: Portarlington (Area 29).

Stomatella impertusa (Burrow).

Haliotis impertusa Burrow, 1825. Elem. Conch., p. 162, pl. 21, f. 2.

MATERIAL: Port Phillip Survey: Area 59 (Portsea Pier).

REMARKS: Anton's designation of this species as the type of *Stomatella* Lamark, 1816, necessitates the use of this generic name and the suppression of *Gena* as a junior homonym. (See remarks under *Granata imbricata*, page 209).

Family TURBINIDAE.

Subninella undulata (Solander).

Turbo undulata Solander, 1786. Cat. Portland Mus., p. 18.

Limax undulatus Martyn, 1784. Univ. Conch. 1, f. 29.

MATERIAL: Port Phillip Survey: Areas 6 (118); 59 (23, 36, 80–1); 64 (164). Nat. Mus. Coll.: Hobsons Bay (Areas 2–3); Ricketts Point (Area 23); Sorrento, Portsea (Area 59); back beach Sorrento (Area 59–66).

REMARKS: This is a shallow water herbivorous species confined to rock platforms from low tide level to a few feet in depth where algal growth is strongest. At low tide level it is often very abundant.

Micrastraea aurea (Jonas).

Trochus aurea Jonas, 1844. Zeits., f. Malak.; p. 168.

Carinidea granulata Swainson, 1855. Proc. roy. Soc. Van Diemen's Land, 3, p. 40, pl. 6, f. 5, 6.

MATERIAL: Port Phillip Survey: Areas 6 (118, 137); 13 (93); 14 (175, off Quiet Corner); 27 (41); 28 (316); 30 (130. 135, 280); 39 (42, 313); 40 (101); 42 (281); 50 (238); 55 (148); 59 (23, 25, 213). Nat. Mus. Coll.: Portarlington (Area 29); Schnapper Point (Area 55); Portsea (Area 58).

REMARKS: This species occurs on reefs where algae or uneven surface such as small stones provide it with some shelter. Its range is from low tide to at least seven fathoms.

Phasianella australis (Gmelin).

Buccinum australe Gmelin, 1788. Syst. Nat., p. 3490, No. 173.

Phasianella australis Philippi, 1853. Conch. Cab. ( ), p. 2, pl. 1, f. 1–7 and pl. 2, f. 1.

MATERIAL: Port Phillip Survey: Areas 42 (38, low tide); 50 (230–1); 59 (23); Gatliff Coll.: Portsea Sorrento (Area 59); Corio Bay (Area 25, 37–38); Mud Island (Area 60); Barwon Heads (Area 56).

REMARKS: Occurs where algal covered rocks and sand are associated.

Phasianella ventricosa (Quoy and Gaimard).

Phasianella ventricosa Quoy and Gaimard, 1834. Voy. "*Astrolabe*" Zool., 3, p. 237, pl. 59, f. 8, 9.

MATERIAL: Port Phillip Survey: Area 58 (151). Nat. Mus. Coll.: Port Phillip Heads (Area 58).

REMARKS: Pritchard and Gatliff note that this species is relatively uncommon in Port Phillip and the above localities show its limited distribution at the southern end of the bay.

Family Neritidae.

Melanerita melanotragus (Smith).

Nerita melanotragus Smith, 1884. Voy. "*Alert*", Zool., p. 69.

Nerita atrata Reeve, 1855. Conch Icon., IX.; pl. 4, f. 16.

MATERIAL: Nat. Mus Coll.: Seaholme (Area 5); Hobson's Bay (Area 2–3).

REMARKS: This is an upper littoral inhabitant of rock platforms so was not taken on the present phase of the survey but it occurs throughout Port Phillip in suitable locations.

Family Littorinidae.

Melarapha unifasciata (Gray).

Littorina unifasciata Gray, 1826. King's Survey of Aust., 2, App., p. 483.

Littorina diemenensis Quoy and Gaimard, 1833. Voy. "*Astrolabe*" Zool. 2, p. 479, pl. 33, f. 8–11.

MATERIAL: Nat. Mus. Coll.: Portarlington (Area 29); Brighton (Area 7); Ricketts Point (Area 23).

REMARKS: This is a supralittoral species of the splash zone of reefs so was not taken on the present survey but it occurs in suitable locations in the southern and eastern portion of the bay.

Melarapha praetermissa (May).

Littorina praetermissa May, 1908. Proc. roy. Soc. Tas., p. 57, pl. 6, f. 3.

MATERIAL: Nat. Mus. Coll.: Portarlington (Area 29); Ocean beach Sorrento (Area 59, 66).

REMARKS: Like the previous species, this is an inhabitant of the supra-littoral of rock platforms and it occurs in suitable locations at the southern end of Port Phillip.

Bembicium auratum (Quoy and Gaimard).

Trochus auratum Quoy and Gaimard, 1834. Voy. "*Astrolabe*". Zool., 3, p. 276, pl. 62, f. 15–16.

MATERIAL: Port Phillip Survey: Area 26 (Limeburners Bay, shallow salt marsh), Area 55 (intertidal Schnapper Pt.). Nat. Mus. Coll.: Ricketts Point (Area 14, 23); Seaholme (Area 5); Williamstown (Area 6); Hobson's Bay (Area 5 and 3).

REMARKS: An upper littoral inhabitant of rock platforms in quiet water, this species occurs both in bays and on open coasts where suitable conditions prevail.

Bembicium melanostomum (Gmelin).

Trochus melanostomum Gmelin, 1791. Syst. Nat., p. 3581, No. 90.

Risella melanostoma Crosse, 1864. Journ. de Conch.; p. 229, pl. XI., f. 1.

MATERIAL: Nat. Mus. Coll.: Altona (Area 5); Brighton (Area 7).

REMARKS: An inhabitant of areas where conditions of extreme shelter prevail, it occurs in the upper littoral of bays, estuaries and salt marsh wherever there is a firm substrate, such as pebbles, shell or mangrove roots for its attachment.

Bembicium nanum (Lamarck).

Trochus nanum Lamarck, 1822. Anim. s. Vert., 7, p. 30; Quoy and Gaimard 1834, Voy. "*Astrolabe*" Zool., 3, p. 276, pl. 62, f. 5–7.

MATERIAL: Nat. Mus. Coll.: Ricketts Point (Area 23); Point Lonsdale Jetty (Area 58); Ocean beach Sorrento (Area 59, 66).

REMARKS: The open coast representatives of the genus *Bembicium*, this species does not occur in the very sheltered waters of Hobson's Bay (Areas 2 and 3).

Family ASSIMINIDAE.

Assiminea brazieri (Tenison Woods).

Rissoina (*Setia*) *brazieri* Tenison Woods, 1876. Proc. roy. Soc. Tas., p. 146.

Rissoa brazieri Tryon, 18. Man. Conch., IX., p. 335, pl. 71, f. 97.

MATERIAL: Port Phillip Survey: 49 (236). Nat. Mus. Coll.: Brighton (Area 7); Black Rock (Area 14).

REMARKS: This estuarine species occurs in the shallow land-locked area at the south end of Swan Bay which although close to Port Phillip Heads, is probably the most sheltered part of Port Phillip.

Assiminea tasmanica Tenison Woods.

Assiminea tasmanica Tenison Woods, 1876. Proc. roy. Soc. Tas., p. 79.

Syncera tasmanica May, 1923. Illustrated Index Tas. Shells, pl. 25, f. 25.

MATERIAL: Port Phillip Survey: 49 (236). Nat. Mus. Coll.: Mordialloc Creek (Area 24).

REMARKS: Occurs with the proceeding species in Swan Bay.

Family VERMETIDAE.

Serpulorbis sipho (Lamarck).

Serpula sipho Lamarck, 1818. Anim. s. Vert., 5, p. 367.

Serpulorbis sipho Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 100, f. 127.

MATERIAL: Port Phillip Survey: Areas 13 (93); 30 (130, 135); 31 (10); 42 (108); 56 (23); 59 (23); 63 (22). Nat Mus. Coll.: Altona (Area 5), St. Kilda (Area 3 and 7), Frankston (Area 48); Portsea (Area 59).

REMARKS: This species is common on rock platforms particularly where the finer sediments and dense weed growth provide the fine particles of organic matter on which it feeds.

Family POTAMIDIDAE.

Velacumantus australis (Quoy and Gaimard).

Cerithium australis Quoy and Gaimard, 1835. Voy. "*Astrolabe*" Zool., 3, p. 131, pl. 55, f. 7.

MATERIAL: Nat. Mus. Coll.: Williamstown (Area 6); Altona (Area 5); Hobson's Bay (Area 2 and 3).

REMARKS: Inhabits the shallow waters of mud flats in areas of extreme shelter.

Zeacumantus diemenensis (Quoy and Gaimard).

Cerithium diemenense Quoy and Gaimard, 1834. Voy. "*Astrolabe*", Zool., 3, p. 128–9, pl. 55, f. 11–13.

MATERIAL: Port Phillip Survey: Area 6 (65–6); 40 (101); 49 (236); 58 (89). Nat. Mus. Coll.: Altona (Area 5); Port Melbourne (Area 2); Swan Bay (Area 49, 50).

REMARKS: Has a similar habitat to the previous species and they are often found living together.

Diala lauta (A. Adams).

Diala lauta A. Adams, 1862. Ann. Mag. Nat. Hist. (3), 10, p. 298, No. 5.

Litiopa (*Diala*) *lauta* Tryon, 1887. Man. Conch. IX., p. 282, pl. 53, f. 83.

MATERIAL: Port Phillip Survey: Areas 27 (41); 39 (42); 30 (280); 40 (101); 49 (236); 15 (284); 39 (313); 42 (intertidal). R. Burn. Coll.: Brighton (Area 7), Portarlington (Area 29); Rye (Area 68). Nat. Mus. Coll.: Portsea (Area 59); Point Henry (Area 26); Portarlington (Area 29).

REMARKS: Associated with *Canthariedella tiberiana* and *Diala montile*, the latter always being in much larger numbers than the two associated species.

Diala monile (A. Adams).

Alaba monile A. Adams, 1862. Ann. Mag. Nat. Hist. (3), 10, p. 296, No. 17.

Diala monile Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 107, f. 134.

MATERIAL: Port Phillip Survey: Areas 27 (41); 30 (280); 40 (101); 48 (32); 39 (313); Gabriel Coll.: Portarlington, Altona. Nat. Mus. Coll.: Point Henry (Area) 26); Portarlington (Area 29).

REMARKS: This species may occur in very large numbers attached to weed in the Corio Bay arm of Port Phillip. It is always associated with *Diala lauta* and *Candhariedella tibertiana* but these species are never as abundant.

Diala pagodula (A. Adams).

Alaba pagodula A. Adams, 1862. Ann. Mag. Nat. Hist. (3), 10, p. 297, No. 15.

Diala pagodula Hedley, 1913. Proc. Linn. Soc. N. S. Wales, 38, pt. 2, p. 287, pl. 18, f. 60.

MATERIAL: Port Phillip Survey: Area 50 (238). Nat. Mus. Coll.: Portarlington (Area 29); Brighton (Area 7).

Diala pulchra (A. Adams).

Alaba pulchra A. Adams, 1862. Ann. Mag. Nat. Hist., (3), X., p. 296, No. 15.

Diala pulchra Hedley, 1913. Proc. Linn. Soc. N. S. Wales, 38, p. 286, pl. 18, f. 57.

MATERIAL: Port Phillip Survey: Area 49 (236). Nat. Mus. Coll.: Portarlington (Area 29); Portsea (Area 58).

Cacozeliana granaria (Kiener).

Cerithium granarium Kiener, 1842. Coq. Vic., p. 72, pl. 19, f. 5.

MATERIAL: 9 (178, 180); 10 (14); 16 (143); 19 (179, 181); 26 (126); 27 (41); 37 (40); 39 (42, 44); 40 (101); 42 (108); 55 (39); 61 (37); 62 (96); 68 (155). Nat. Mus. Coll.: Clifton Springs (Area 29); Portarlington (Area 29).

REMARKS: This species lives on sandy mud banks very often in association with *Zostera*.

Eubittium lawleyanum (Crosse).

Bittium lawleyanum Crosse, 1863. Journ. de Conch. 9, p. 87, pl. 1, f. 4.

MATERIAL: Port Phillip Survey: Areas 58 (89). Nat. Mus. Coll.: Corio Bay (Areas 25, 26, 37, 38); Brighton (Area 7).

REMARKS: On *Zostera* at the head of Swan Bay. This is an area of sheltered water and a substrata of fine sediments but with the clean water conditions not found higher up the Bay.

Hypotrochus monachus (Crosse and Fischer).

Cerithium monachus Crosse and Fischer, 1864. Journ. de Conch., p. 347; ibid., p. 45, pl. 3, f. 17, 18.

MATERIAL: Port Phillip Survey: Areas 10 (11, 14, 15); 11 (190); 50 (230–1); 58 (88). Gabriel Coll.: Point Nepean (Area 58). Nat. Mus. Coll.: Hobson's Bay (Areas 2 and 3).

REMARKS: Occurs on the areas of finer sediments and when present often occurs in considerable numbers.

Ataxacerithium serotinum (A. Adams).

Cerithium serotina A. Adams, 1855. Theo. Conch., 2, p. 861, pl. 180, f. 102.

MATERIAL: Port Phillip Survey: Area 59 (36).

REMARKS: The single specimen from the Pope's Eye (Station 36) and no previous Port Phillip record suggest that it is an infrequent visitor to the Bay.

Family TRIPHORIDAE.

Notosinister maculosa Hedley.

Tryphora maculosa Hedley, 1903. Proc. Linn. Soc. N. S. Wales, 27, p. 614, pl. 32, f. 32–34.

MATERIAL: Port Phillip Survey: Area 59 (36).

Family PYRAMIDELLIDAE.

Cingulina spina (Crosse and Fischer).

Turritella spina Crosse and Fischer, 1864. Journ. de Conch., 12, p. 347, 1865 ibid., 13, p. 44, pl. 3, f. 13, 14.

MATERIAL: Port Phillip Survey: Area 55 (jetty).

Family HIPPONICIDAE.

Hipponyx conicus (Schumacher).

Amalthea conica Schumacher, 1817. Essai. nov. syst. Test, p. 81, pl. 21, f. 4.

MATERIAL: Port Phillip Survey: Areas 59 (23, 25) on *Pleuroploca australis*; 61 (37) on *Notohaliotis ruber*; 64 (166). Nat. Mus. Coll.: Brighton (Area 7); Mornington (Area 55).

REMARKS: Lives attached to other shells.

Antisabia foliacea (Quoy and Gaimard).

Hipponyx foliacea Quoy and Gaimard, 1835. Voy. "Astrolabe" Zool., p. 439, pl. 72, f. 41–45.

MATERIAL: Nat. Mus. Coll.: Sorrento (Area 59).

Family CAPULIDAE.

Capulus violacea Angas.

Capulus violaceus Angas, 1867. Proc. Zool. Soc., p. 114, pl. 13, f. 23.

MATERIAL: Port Phillip Survey: Area 30 (280) attached to *Micrastrea aurea*.

Family CALYPTRAEIDAE.

Sigapatella calyptraeformis (Lamarck).

Trochus calyptraeformis Lamarck, 1822. Anim. s. Vert., 7, p. 12, No. 7, Delesert 1841, Recueil Coquilles, pl. 34, f. 7, a, b, c.

MATERIAL: Port Phillip Survey: Areas 6 (137); 7 (206); 11 (190); 13 (83, 92); 15 (284); 31 (276); 49 (236); 50 (230–1); 55 (37, 147); 58 (88); 61 (37); 64 (164). Gabriel Coll.: Point Cook (Area 5). Nat. Mus. Coll.: Mentone (Area 24).

REMARKS: This species prefers areas with a silty substratum but needs a solid object on which to rest, thus it is common on the areas where there is skeletal material such as dead shell (Beasley, Mem. nat. Mus. No. 27, fig. 2) to which it can attach itself.

Zeacrypta immersa (Angas).

Crepidula immersa Angas, 1865. Proc. Zool. Soc., p. 57, pl. 2, f. 12.

MATERIAL: Port Phillip Survey: Areas 6 (65–6, 137); 13 (94); 14 (117). Nat. Mus. Coll.: Hobson's Bay (Area 2 and 3); Brighton (Area 7); Queenscliff (Areas 50, 59).

REMARKS: A sedentary species that attaches itself to other molluscs and occasionally to stones. Specimens collected at Station 117 in November, 1959, were brooding egg masses.

Family NATICIDAE.

Conuber conicum (Lamarck).

Natica conica Lamarck, 1822. Anim. s. Vert., 6, p. 198; Reeve 1855, Conch. Icon., IX. (Natica), pl. 12, f. 48; Finlay and Marwick 1937 Palaeont. Bull. N. Z., 15, p. 53; Murray 1962, Journ. Malac. Soc. Aust., No. 6, p. 49–58.

MATERIAL: Port Phillip Survey: Areas 42 (38); 59 (36); 61 (37). Nat. Mus. Coll.: Portarlington (Area 29); Mentone (Area 24); Cheltenham (Area 13); Sorrento (Area 59).

REMARKS: This is a shallow water species of the sand flats ranging from low tide to approximately two fathoms. Because of this it was taken infrequently on the survey although very common in suitable habitats throughout Port Phillip Bay.

Finlay and Marwick 1937 erected the subgenus *Conuber* for this southern and eastern Australian species, because it differs from *Polinices* s.s. in its consistently high conical shape, the course of its growth lines and the peculiar way in which the parietal callus ends abruptly, leaving exposed a narrow umbilicus and half of the funicle.

Later authors gave it full generic status but Macpherson and Gabriel, 1961, did not consider this warranted.

However recent work by F. M. Murray (1963) has shown that this species, together with *P. sordidus* Swainson, *P. melastoma* Swainson, and *P. incei* Philippi, has the egg mass in the form of a jelly (or sausage collar) from which hatch veliger larvae, instead of the sand collar and crawling young known to be the form of reproduction in most species of Naticidae.

It is therefore suggested that *Conuber* should be used for those species of Naticid which produce their eggs in a jelly mass from which hatch veliger larvae. This would also require that Finlay and Marwicks description of the genus be widened to include broader, more flattened shells, with the umbilicus nearly or completely filled by the parietal callus such as *melastoma* and *incei*.

Glossaulax aulacoglossa (Pilsbry and Vanatta).

Polinices aulacoglossa Pilsbry and Vanatta, 1908. Proc. Acad. Nat. Sc. Phil., 55, p. 558, pl. 29, f. 1, 2, 3.

MATERIAL: Port Phillip Survey: Areas 42 (38); 55 (35); 61 (37); Nat. Mus. Coll.: Hobson's Bay (Area 2 and 3); Mentone, Mordialloc (Area 24); Portsea (Area 59).

REMARKS: This sand dwelling shallow water species lays its egg mass as a typical naticid sand color. In view of the different types of development now known to occur in the Naticids, it seems advisable to show these differences by the separation of *Polinices* s.l. into restricted genera and I therefore advocate the use of *Glossaulax* for the Indo-Pacific species with a grooved umbilical callus.

Sigaretotrema umbilicata (Quoy and Gaimard).

Natica umbilicatum Quoy and Gaimard, 1833. Voy. "*Astrolabe*" Zool., 2, p. 234, pl. 66, f. 22–3.

MATERIAL: Port Phillip Survey: Area 10 (14). Nat. Mus. Coll.: Sorrento (Area 59); Ocean Beach Sorrento (Area 59); Mud Is. (Area 60).

REMARKS: This species also lives in shallow water but occurs on muddy sand in similar situations to and therefore in association with plant growth such as *Caulerpa* or *Zostera*.

Ectosinum zonale (Quoy and Gaimard).

Cryptosoma zonale Quoy and Gaimard, 1833. Voy. "*Astrolabe*", Zool., 2, p. 221, pl. 66, f. 1–3.

MATERIAL: Port Phillip Survey: Area 6 (118); 42 (289). Nat. Mus. Coll.: Port Melbourne (Area 2); Hobson's Bay (Area 2 and 3); Dromana (Area 63, 70); Swan Bay (Area 49–50); Portsea (Area 59).

REMARKS: This like the previous species, is a dweller of muddy sand flats ranging from shallow water to several fathoms in depth.

Family LAMELLARIIDAE.

Lamellaria sp.

MATERIAL: Port Phillip Survey: Areas 59 (36, 213); Area 27 (138–9). Nat. Mus. Coll.: Portarlington (Area 29); Portsea (Area 59); Pope's Eye (Area 59).

REMARKS: Several species of this genus were taken in association with sponges and Ascidians, during the course of the survey. However, it has been realized for some time that a revision of the Australian species is necessary and, as Mrs. Slack–Smith is at present working on the group, it is thought inadvisable to discuss the Port Phillip material alone.

Family CYPRAEIDAE.

Notocypraea angustata (Gmelin).

Cypraea angustata Gmelin, 1791. Syst. Nat. 6, p. 3421; Reeve 1846, Conch. Icon., 3, pl. 17, f. 91.

MATERIAL: Port Phillip Survey: Area 59 (36); Nat. Mus. Coll.: Portsea, Sorrento (Area 59).

REMARKS: The *Notocypraea* are inhabitants of clear water and so were only taken in the vicinity of Port Phillip Heads.

Notocypraea comptoni (Gray).

Cypraea comptoni Gray, 1847. Juke's Voy. H. M. S. "*Fly*" 2, p. 356, pl. 1, f. 3.

MATERIAL: Port Phillip Survey: Area 66 (292). Nat. Mus. Coll.: Altona (Area 5); Portsea (Area 59), Port Phillip Heads (Area 58).

Family CASSIDIDAE.

Xenogalea pyrum (Lamarck 1822).

Cassis pyrum Lamarck, 1822. Anim. s. Vert., 7, p. 226; Reeve 1848, Conch. Icon., 5, pl. 11, f. 29.

MATERIAL: Port Phillip Survey: Area 59 (36). Nat. Mus. Coll.: Sorrento, Portsea (Area 59); Queenscliff (Area 58).

REMARKS: A sand dwelling species found only on the sandy bottom of the southern part of Port Phillip Bay.

Family CYMATIIDAE.

Cymatiella verrucosa (Reeve).

Triton verrucosa Reeve, 1844. Conch. Icon., 2, pl. 17, f. 71.

MATERIAL: Port Phillip Survey: Area 42 (38, 108); 58 (151); 59 (23, 36); Gatliff Coll.: Sorrento (Area 59). Nat. Mus. Coll.: Point Cook (Area 5); Geelong (Area 37); Portarlington (Area 29), Sorrento (Area 59).

REMARKS: This small species occurs amongst algae on reefs and because it is difficult to see, is probably more common than records suggest.

Cymatiella lesueuri Iredale 1929.

Cymatiella lesueuri Iredale, 1929. Rec. Aust. Mus., 17, p. 175, pl. 40, f. 11

MATERIAL: Port Phillip Survey: Area 42 (108). Burn Coll.: Portarlington (Area 29); Sorrento (Area 59).

REMARKS: Like the previous species it lives on reefs. It is apparently very common on off-shore ocean reefs, as shown by the number of beach specimens that occur along the coast.

Cabastana spengleri (Perry).

Septa spengleri Perry, 1811. Conchology, pl 14, f. 3.

MATERIAL: Port Phillip Survey: Areas 59 (79); 63 (163); 64 (—). Nat. Mus. Coll.: Altona (Area 5); Portsea, Sorrento (Area 59); Point Lonsdale (Area 58); Mordialloc (Area 24).

REMARKS: A common shell on the rock platforms of the south-eastern coast of Australia, it comes into shallow water in early spring to spawn.

Specimen from station 79 is elongate in form, a feature Iredale suggests is more typical of deep water specimens whereas perhaps it is a feature of quiet waters whether due to depth or shelter.

Cabestana waterhousei (Adams and Angas).

Triton waterhousei Adams and Angas, 1864. Proc. Zool. Soc., p. 35.
Cabastana waterhousei Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 160, f. 193.

MATERIAL: Port Phillip Survey: Area 42 (109); 51 (271); 64 (164). Nat. Mus. Coll.: Mud Is. (Area 60); Sorrento (Area 59). Burn Coll.: Portarlington (Area 29).

REMARKS: A species with similar habit to the previous one.

Family Muricidae.

Pterynotus triformis (Reeve).

Murex troformis Reeve, 1845. Conch. Icon., 3, pl. 13, sp. 53.

MATERIAL: Port Phillip Survey: Areas 9 (178, 180); 19 (179, 181); 28 (140, 285); 30 (130, 135); 55 (22). Nat. Mus. Coll.: Brighton (Area 7); Mordialloc (Area 24); Beaumaris (Area 14); Mud. Is. (Area 60).

REMARKS: Common living amongst brown algae on reefs, particularly in the northern section on the finer bottom type sediments.

Bedeva paivae (Crosse).

Trophon paivae Crosse, 1864. Journ. de Conch., 12, p. 278, pl. 11, f. 7.

MATERIAL: Port Phillip Survey: Areas 3 (202); 5 (52, 166); 6 (137); 7 (206); 10 (11); 13 (15, 92–3); 14 (175); 16 (283); 19 (304–6); 24 (122); 28 (316); 39 (42, 45); 42 (38); 50 (238); 55 (147); 62 (96, 244); 63 (16–20, 163); 64 (164). Nat. Mus. Coll.: Hobson's Bay (Areas 2 and 3). Brighton (Area 7).

REMARKS: An uncommon shell in the early records possibly because collectors either took strand-line specimens or did not collect at extreme low tide. The survey has shown it to be very common in Port Phillip.

Lepsiella vinosa (Lamarck).

Baccinum vinosa Lamarck, 1822. Anim. s. Vert., 7, p. 273.
Lepsiella vinosa Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 178, f. 214.

MATERIAL: Port Phillip Survey: Area 42 (38). Nat. Mus. Coll.: Port Phillip.

REMARKS: This is a carnivorous species usually living intertidally and feeding on other less active molluscs such as limpets and mussels.

Dicathais textilosa (Lamarck).

Purpura textilosa Lamark, 1822. Anim. s. Vert., 7, p. 242; Quoy and Gaimard, 1833, Voy. "*Astrolabe*" Zool., vol. 2, p. 552, pl. 37, f. 1–3.

MATERIAL: Port Phillip Survey: Area 59 (23, 24, 36, 79, 213). Nat. Mus. Coll.: Mordialloc (Area 24); Mud Is. (Area 60); Sorrento (Area 59).

Family COLUMBELLIDAE.

Dentimitrella (Ludbrook, 1958).

The members of the genus *Dentimitrella* are all small, less than 25 mm. in length and the colour patterning of red-brown flames, streaks, spots &c., on a usually white background is very variable within a species and may be very similar in several species. This has led to the introduction of a large number of names for a comparatively small number of species and of the lumping of valid species with similar colour patterns.

In fresh specimens living in sheltered waters the colour pattern may be partly obscured by a very fine periostracum which gives the shell a uniform horn or brown appearance. In many mature specimens and in all beach material this periostracum becomes completely eroded away.

Also it is unfortunate that Gaskoin named twenty species mainly without locality or figure. However, his descriptions are very detailed and Reeve implies that he has used actual specimens from the Gaskoin collection for his figures of the species. It is on this assumption that the following classification of the Victorian shells is made.

1. Shell large, stout, more than 16 mm. long—*semiconvexa*.
   Shell 15 mm. or less—2.

2. Shells approximately 15 mm.—3.
   Shells approximately 11 mm. or less—4.

3. Shell tapering.
   Whorls flattened aperture $\frac{1}{3}$ length = *menkeana*.
   Shells ovate whorls convex aperture $\frac{3}{5}$ = *pulla*.

4. Shells approximately 11 mm.—5.
   Shells 11 mm. or less—6.

5. Shell white solid with flesh coloured band on body whorl, whorls convex *austrina*.
   Shells tapering, width $\frac{3}{5}$ the length = *lincolnensis*.

6. Shells broad width $\frac{3}{5}$ length = *nubeculata*.
   Shell very small less than 4 mm. long = 7.

7. Spire very short less than length of body whorl = *franklinensis*.
   Spire longer than body whorl = *tenisoni*.

Dentimitrella semiconvexa (Lamarck).

Buccinum semiconvexum Lamarck, 1822. Anim. s. Vert. VII., No. 33.
Columbella semiconvexa Sowerby, 1847. Thes. Conch. 1, pl. 38, figs. 103, 104.
Columbella strigata Reeve, 1859. Conch. Icon., XI., Species 154.

MATERIAL: Port Phillip Survey: Areas 6 (137); 13 (92–3); 27 (41); 58 (88, 151 intertidal Point Lonsdale); 59 (25, 36). Nat. Mus. Coll.: Portarlington (Area 29); Sorrento (Area 59).

Shell ovate, stout, white and usually flamed with longitudinal red-brown zigzag markings but the pattern shows great variation and may be lacking entirely. The periostracum is pale straw coloured when present, interior of mouth is usually pale mauve. Whorls usually 6 plus the protoconch, convex sculptured with fine encircling lirae. Aperture oblong nearly half the length of the shell and with 8 to 9 denticles on the inner side of the outer lip.

Average dimensions: 20 mm. by 9 mm.

REMARKS: This is the commonest Victorian species and its large size and stout form make it easily recognized. *C. australis* Gaskoin has been considered to be a smaller form of this species but comparison of typical *australis* from Sydney, the type locality with Victorian *semiconvexa* shows them to be distinct species.

Dentimitrella menkeana (Reeve).

Columbella acuminata Menke, 1843 (non Nuttal). Moll. Nov. Holl., p. 20, No. 87.
Columbella menkeana Reeve, 1858. Conch. Icon., XI., Species 69, f. a. b.
Columbella xavierana Tenison Woods, 1876. Proc. roy. Soc. Tas., p. 134.

MATERIAL: Port Phillip Survey: Areas 39 (313); 58 (88).

Shell narrow acuminate, smooth, white and usually encircled beneath the suture with a brown band which may be either almost continuous or broken into chevrons. Shells with a continuous band are usually uniform yellow brown in colour while broken banded specimens often show additional brownish flames and spots. Periostracum is pale yellow in colour. Whorls, flat, 8 or 9 plus the protoconch which is small and continues the shell taper. Aperture short, narrow, approximately one third the length of the shell, denticulate within.

Average dimensions—16 mm. by 6 mm.

REMARKS: Similar in shape to *lincolnensis* but a larger shell with more whorls and slightly stouter form, also the predominant colour pattern aids identification.

Dentimitrella pulla (Gaskoin).

Columbella pulla Gaskoin, 1851. Proc. Zool. Soc. Lond., p. 6; Reeve 1858, Conch. Icon., XI., Species 106.
Columbella saccharata Reeve, 1858. Ibid.; Species 187.
Columbella tenebrica Reeve, 1859. Ibid.; Species 204.
Columbella nux Reeve, 1859. Ibid.; Species 227.
Columbella badia Tenison Woods, 1875. Proc. roy. Soc. Tas., p. 151.

MATERIAL: Port Phillip Survey: Areas 10 (11); 13 (92–3); 27 (41); 30 (280, 303) juveniles; 40 (101); 42 (108); 50 (230–1); 59 (36); 68 (155). R. Burn Coll.: Portarlington (Area 29).

Shell ovate, white or pale straw coloured and variously patterned with red-brown, (one form is uniform white or cream except for a red-brown band just below the suture).

Whorls 6 or 7 slightly convex, tapering to a small bulbous brown protoconch. Periostracum corn coloured. Aperture rather broad $\frac{3}{5}$ length of shell, denticulate on inner edge of both inner and outer lips, denticles on outer lip 8 to 10 and reaching almost to posterior end. Interior of mouth often pinkish-mauve tinted.

Average dimensions: 14 mms. by 6 mms.

REMARKS: Close in size to *menkeana* this species is immediately separated by its stouter form, convex whorls and less tapering appearance. Some examples of this species have been called C. *tenuis* Gaskoin, but no Victorian specimens in the National Museum collections correspond to Gaskoin's description nor Reeve's figure (224).

Dentimitrella austrina (Gaskoin).

Columbella austrina Gaskoin, 1851. Proc. Zool. Soc. Lond., p. 9; Reeve 1859 Conch. Icon., XI., Species 100.

Columbella annulata Reeve, 1858. Ibid.; Species 101.

? *Columbella rosacea* Reeve 1859. Ibid.; Species 183.

MATERIAL: It was not taken in the present survey but Pritchard and Gatliff list it from Corio Bay (Areas 25, 30).

Shell oblong-ovate, ivory white, shining, last whorl encircled with a broad flesh coloured band extending from the periphery to a line level with the top of the columella. This colouring may be obscured by the very fine, horn coloured periostracum.

Whorls 5 to 6 plus the protoconch, flattened, tapering with slightly impressed sutures. Aperture squarely ovate, wide about half the length of the shell, notched at the posterior outer lip, conspicuously denticulate within, columella reflected and showing a few fine denticles.

Average dimensions 12 mms. by 5 mms.

REMARKS: This species is easily separated by its squat solid form and distinctive colouring.

Dentimitrella lincolnensis (Reeve).

Columbella lincolnensis Reeve, 1859. Conch. Icon., XI., Species 184 a. b.

MATERIAL: Nat. Mus. Coll.: Sorrento (Area 59).

Shell acumately solid, smooth, white variously streaked striped or checked with chestnut and when uneroded covered with a fine straw coloured periostracum.

Whorls 6 or 7 plus the protoconch which is small and continues the taper of the shell. Aperture elongate, third the length of the shell and bearing 6 to 8 denticles on the inner side of the outer lip.

Average dimensions: 12 mm. by 4 mm.

Victorian specimens are smaller than those from South Australia.

REMARKS: This species is very similar in form to *menkeana* but is smaller and more delicate with fewer whorls.

Dentimitrella nubeculata (Reeve).

Columbella nubeculata Reeve, 1859. Icon., XI., Species 234.
Columbella dictua Tenison Woods, 1878. Proc. roy. Soc. Tas., p. 34.
Columbella vincta Tate, 1893. Trans. roy. Soc. S. Aust., XVII., p. 190, pl. 1, f. 11.

MATERIAL: R. Burn Coll.: Portarlington (Area 29).

Shell oblong, ovate smooth, variously mottled with yellow orange and brown and showing great variation in the colour pattern, apex violet tinged. Whorls convex, 6 plus the protoconch. Aperture narrow less than half length of shell, outer lip prominently toothed, teeth usually six but may be one or two small additional teeth at the anterior end.

Average dimensions: 10 mms. by 4 mms.

REMARKS: Some colour forms of this species may be confused with *pulla* but its smaller size fewer whorls and denticles on the outer lip separate the two species. Juveniles of this species seems to be very similar in form and colouring to *D. axiarata* Verco. Comparison was with a specimen in the Gatliff Collection presented by the author.

Dentimitrella franklinensis (Gatliff and Gabriel).

Columbella franklinensis Gatliff and Gabriel, 1910. Proc. roy. Soc. Vict., 23 (n.s.), pt. 1., p. 83, pl. XVIII., fig. 3.

MATERIAL: Was not taken on the present survey but the original description lists it from Point Franklin and Portsea which are in Area 59.

The author's description is as follows: "Shell small, smooth acuminate, of six whorls; the body whorl is inflated, and is rather more than half the length of the shell. Whorls convex, suture well defined. Fine ascending striae encircle the base, and cease at the columella; base somewhat restricted with slightly reverted snout. Outer lip thickened, shouldered at its junction with the body whorl, smooth interiorly. Mouth lanceolate. Colour yellowish white, somewhat translucent".

Length 3 mm.

Dentimitrella tenisoni (Tryon).

Columbella minuta Tenison Woods, 1875 (non Gould). Proc. roy. Soc. Tas., p. 152
Columbella tenisoni Tryon, 1883. Man. of Conch., V., p. 128, pl. 49, fig. 10

MATERIAL: Not recorded from Port Phillip but the description is included here to make this review of the Victorian *Dentimitrella* complete.

Tryons description is as follows: "Shell ovate, sub-biconical, smooth, shining; pale chestnut very thickly ornamented with chestnut longitudinal lines, sometimes with two revolving bands of white spots; whorls 5, somewhat flatly tumid, aperture ovate, acute posterior outer lip thickened, dentate within".

Length 3 mill.

Macrozafra angasi (Brazier).

Columbella interrupta Angas 1865 (non Gaskoin). Proc. Zool. Soc., p. 56, pl. 2, f. 9, 10.
Columbella angasi Brazier, 1871. Ibid., p. 322.

MATERIAL: Port Phillip Survey: Areas 27 (41); 30 (280). Nat. Mus. Coll.: Outer Geelong Harbour (Areas 26, 38); Portarlington (Area 29); Brighton (Area 7).

Family Buccinidae.

Austrosipho grandis (Gray).

Fusus grandis Gray, 1839. Beechey's Voy. Zool., p. 116.

Austrosipho grandis Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 187–8, f. 223.

MATERIAL: Port Phillip Survey: Area 58 (151); Gatliff Coll.: Frankston (Area 48); Portsea (Area 58–9); Sorrento (Area 59); Mordialloc (Area 34).

REMARKS: A deep water inhabitant of Bass Strait which is only occasionally found in Port Phillip Bay.

Cominella eburnea (Reeve).

Buccinum eburnea Reeve, 1846. Conch. Icon., 3, pl. 12, sp. 93.

MATERIAL: Port Phillip Survey: Areas 5 (168); 6 (118); 7 (206); 10 (106); 13 (92); 42 (38); 58 (89). Nat. Mus. Coll.: Portarlington (Area 27); Port Melbourne (Area 2).

REMARKS: This species lives in shallow areas of sandy mud and is common where *Zostera* bed provide shelter for the bivalve population on which it feeds.

Cominella lineolata (Lamarck).

Buccinum lineolata Lamarck, 1809. Encly. Meth., pl. 400, f. 8.

MATERIAL: Port Phillip Survey: Areas 42 (38); 48 (32); 55 (35); 58 (89); 59 (23); 63 (163). Nat. Mus. Coll.: Port Phillip, material was not localized.

REMARKS: This species is an inhabitant of reefs in shallow water occurring from mid-tide level down to several fathoms. On the open coast it is commonly found at mid-tide level feeding on the mussel *Brachidontes rostratus*. In Port Phillip it rarely penetrates above low water level.

Family Nassidae.

Parcanassa pauperata (Lamarck).

Buccinum pauperata Lamarck, 1822. Anim. s. Vert., 7, p. 278.

Nassa pauperata Reeve, 1853. Conch. Icon., 8, pl. 5, f. 27.

MATERIAL: Port Phillip Survey: Areas 6 (118); 9 (84); 10 (106); 42 (38); 58 (89); 61 (37).

REMARKS: An inhabitant of the sandy mud areas feeding on bivalves.

Parcanassa burchardi (Philippi).

Buccinum burchardi Philippi, 1851. Abbild. Beschr. Conch., 3, p. 69, pl. 2, f. 14.

MATERIAL: Port Phillip Survey: Area 21 (115); Gabriel Coll.: Port Phillip.

REMARKS: Previously recorded from but not localized within Port Phillip this was a rare shell on the survey only being taken at the one station in the central mud basin.

Tavaniotha optata (Gould).

Nassa optata Gould, 1860. Proc. Boston Nat. Hist. Soc. VII., p. 331; Hedley 1915. Proc. Linn. Soc. N. S. Wales 39, pt. 4; p. 736–7, pl. 83, fig. 78.

MATERIAL: Port Phillip Survey: Areas 3 (202); 5 (58); 7 (206, 208); 17 (173); 19 (181, 304–6); 27 (49); 31 (—); 36 (76); 42 ( ); 43 (303); 50 (228, 230); 55 ( ) 58 (88); 59 (36); 61 (240); 62 (96); 63 (16–20); 68 (158).

REMARKS: This species is an inhabitant of the shallower water sands and muddy sands from low tide down to approximately nine fathoms. It is not found within the central mud basin.

Niotha pyrrhus (Menke).

Buccinum pyrrhus Menke, 1843. Moll. Nov. Holl., p. 21; No. 93.

Niotha pyrrhus Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 196, f. 233.

MATERIAL: Port Phillip Survey: Areas 6 (118); 9 (62); 37 (40, 296); 39 (313); 40 (101); 42 (38, 107–8); 55 (—); 59 (36); 61 (37). Nat. Mus. Coll.: St. Kilda (Area 3); Brighton (Area 7); Mordialloc (Area 24); Portsea (Area 59); Portarlington (Area 29). Hobson's Bay (Area 2 and 3).

REMARKS: This species tends to favour areas of sandy mud with weed growth and therefore its distribution is more restricted than the previous species.

Family Fasciolariidae.

Pleuroploca australasia (Perry).

Pyrula australasia Perry, 1811. Conch., pl. 54, f. 4.

MATERIAL: Port Phillip Survey: Areas 6 (63); 13 (92); 16 (137); 17 (170); 29 (174, 317); 28 (140); 30 (130, 132); 37 (40); 40 (101); 42 (38); 55 (35); 58 (151–2); 59 (23, 25); 61 (37); 64 (164); 68 (157). Nat. Mus. Coll.: Mordialloc (Area 24); Frankston (Area 48); Portsea (Area 59); Altona (Area 5).

REMARKS: A specimen at Station 35 was feeding on *Notocallista kingii*.

Microcolus dunkeri (Jonas)?

Fusus dunkeri Jonas, 1844. Malak. Beitrog., p. 129.

Microcolus dunkeri Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 201–2, f. 240.

MATERIAL: Port Phillip Survey: Area 39 (313). Nat. Mus Coll.: Sandringham (Area 13–4).

REMARKS: A single immature specimen which matches other Victorian specimens very well except that the protoconch is smaller and lacks the characteristic smokey blue colour of most specimens.

Family Olividae.

Alocospira marginata (Lamarck).

Ancillaria marginata Lamarck, 1810. Ann. das. Mus., vol. XVI., p. 304.

Ancillaria marginata Reeve, 1864. Conch. Icon., vol. XV., pl. 3, f. 8 a. b.

MATERIAL: Port Phillip Survey: Area 58 (151). Gabriel Coll.: Mornington (Area 55); Dromana (Area 63, 70); Point Nepean (Area 58–9); Point Lonsdale (Area 58).

REMARKS: Lives in sand but was only taken at one station on the present survey, possibly due to the fact that most collecting was done in daylight and a grab was not used. These shells tend to bury themselves just below the surface in daylight, emerging at night to feed.

Family Mitridae.

Austromitra tasmanica (Tenison Woods).

Mitra tasmanica Tenison Woods, 1875. Proc. roy. Soc. Tas., p. 139.

Austromitra tasmanica Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 209, f. 249.

MATERIAL: Port Phillip Survey: Areas 59 (36); 58 (88); 39 (42).

Mitra australis (Swainson).

Mitra australis Swainson, 1822. Zool. Illust., 1, 1st series, pl. 18.

MATERIAL: Port Phillip Survey: Area 39 (44). Gabriel Coll.: Sorrento (Area 59); Point Nepean (Area 58); Queenscliff (Area 58).

Eumitra glabra (Swainson).

Mitra glabra Swainson, 1821. Exotic Conch., 1, pl. 24.

MATERIAL: Port Phillip Survey: Area 66 (292).

Family Volutidae.

Amorena undulata (Lamarck).

Voluta undulata Lamarck, 1804. Ann. du. Mus., vol. V., p. 157, pl. 12, f. 1, a. b.

MATERIAL: Port Phillip Survey: Areas 59 (23); 68 (157). Gabriel Coll.: Frankston (Area 48); Queenscliff (Area 58); Sorrento (Area 59).

REMARKS: This species lives in sand and bulldozes through just beneath the surface in search of food.

Family Marginellidae.

Cryptospira pygmaeoides (Singleton).

Marginella pygmaeoides Singleton, 1937. Proc. roy. Soc. Vic., 49, p. 393, pl. 23, f. 2.

MATERIAL: Port Phillip Survey: Areas 59 (36). Nat. Mus. Coll.: Portsea, Sorrento (Area 59).

REMARKS: A sand dwelling species which was found in large numbers on the sand bottom within the comparative shelter of the annulus of artificial reef that form the Pope's Eye (Station 36).

Austroginella johnstoni (Petterd).

Marginella johnstoni Petterd, 1884. Journ. of Conch., 4, p. 143; May, 1923. An Illustrated Index of Tasmanian Shells, pl. 31, fig. 2.

MATERIAL: Port Phillip Survey: Areas 59 (36); 62 (96). Nat. Mus. Coll.: Brighton (Area 7); Mornington (Area 55); Sandringham (Area 13); Sorrento (Area 59). F. Murray Coll.: Rosebud (Area 69).

REMARKS: Lives in sand and was very common at station (36) and at Rosebud.

Family Turridae.

Mitraguraleus mitralis (A. Ads. and Angas).

Bela mitralis Adams and Angas, 1863. Proc. Zool. Soc., p. 420, No. 8.

MATERIAL: Port Phillip Survey: Areas 59 (36).

Family Conidae.

Floroconus anemone (Lamarck).

Conus anemone Lamarck, 1810. Ann. du Mus., 15 p. 272; Reeve 1843, Conch. Icon., vol. 1, pl. 25, f. 139, a. b.

MATERIAL: Port Phillip Survey: Areas 42 (38); 59 (23, 24). Nat. Mus. Coll.: Geelong (Area 30); Mt. Martha (Area 63); Mud. Is. (Area 60); Schnapper Point (Area 55); Brighton (Area 7); Portarlington (Area 29).

REMARKS: Is an inhabitant of reefs from low tide to approximately one fathom where it often occurs under stones in quite large numbers. For this reason although common round the shores of Port Phillip it was not a prominent species in the present survey.

Family AMPHIBOLIDAE.

Salinator fragilis (Lamarck).

Ampullaria fragilis Lamarck, 1822. Anim. s. Vert., 6, p. 179.

MATERIAL: Port Phillip Survey: Area 26 (Limeburners Bay, shallow salt marsh). Nat. Mus. Coll.: St. Kilda (Area 3); Sandringham (Area 18); Hobsons Bay (Area 2 and 3); Altona (Area 5); Frankston (Area 48).

REMARKS: This species occurs in the lower littoral of salt marshes and estuaries and is known to be common in such suitable positions around the shores of Port Phillip. Their actual distribution, and that of the allied species *S. solida* (van Martens) will be plotted in detail when the survey is extended to the shoreline.

Siphonaria diemenensis (Quoy and Gaimard).

Siphonaria diemenensis Quoy and Gaimard, 1833. Voy. "*Astrolabe*" Zool., 2, p. 327, pl. 25, f. 1–12.

MATERIAL: Port Phillip Survey: Area 42 (38); 59 (36); 61 (37). Nat. Mus. Coll.: Portarlington (Area 27); Williamstown (Area 6); Mt. Eliza (Area 55); Brighton (Area 7); Rye (Area 68).

REMARKS: This is a very common species in the intertidal area on rock platforms and it is found in all such locations in Port Phillip occurring on the artificial breakwaters of Areas 2 and 3.

Class **BIVALVIA.**

Family NUCULIDAE.

Leionucula obliqua (Lamarck).

Nucula obliqua Lamarck, 1819. Anim. s. Vert., 6, p. 59.

Leionucula obliqua Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 270, f. 307.

MATERIAL: Port Phillip Survey: Areas 12 (111–3); 13 (210); 23 (71); 31 (—); 43 (263); 53 (253); 55 (146); 61 (240); 63 (163). Gabriel Coll.: Brighton (Area 7); off Beaumaris (Area 23); Point Cook (Area 5). Nat. Mus. Coll.: Hobson's Bay (Area 2 and 3); Point Cook (Area 5); Mornington (Area 55).

REMARKS: Lives in sandy mud at approximately 3 to 10 fathoms in depth.

Family ARCIDAE.

Anadara trapezia (Deshayes).

Anadara trapezia Deshayes, 1840. Mag. Zool., pl. 21.

MATERIAL: Port Phillip Survey: Areas 12 (114); 26 (126); 27 (41); 28 (285); 37 (40); 39 (40, 42, 313).

REMARKS: This species was thought for a long time to be extinct in Port Phillip but the present survey has shown it to be in quite large numbers on the north-western side of the Bay and in particular in the Corio Bay arm. The Quaternary beds of the Yarra delta contain large numbers of this shell and it has been suggested that climatic changes caused its disappearance. However, in view of the evidence from the present survey, it seems more likely that its disappearance from this particular section is due to ecological changes as a result of pollution

and dredging. *Anadara* is a heavy shell which would remain unaffected by solution and erosion and so the delta beds would be built up readily over a period. Also size of living specimens from the present survey do not indicate that these shells are stunted in comparison with the quaternary specimens of the Yarra delta.

Barbatia pistachia (Lamarck).

Arca pistachia Lamarck, 1819. Anim. s. Vert., 6, p. 41.

Barbatia pistachia Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 276, f. 314.

MATERIAL: Port Phillip Survey: Areas 6 (65, 137, 167); 10 (11–2); 14 (175); 18 (60); 23 (3); 55 (148–9); 61 (37); 63 (163); 64 (164). Nat. Mus. Coll.: St. Kilda (Area 3–7); Mordialloc (Area 24); Frankston (Area 48); Portsea (Area 58–9); Geelong (Area 37).

REMARKS: A common species at and below low tide on reefs.

Barbatia squamosa (Lamarck).

Arca squamosa Lamarck, 1819. Anim. s. Vert., 6, p. 45.

Barbatia squamosa Macpherson and Gabriel 1962. Marine Molluscs of Victoria, p. 277, f. 315.

MATERIAL: Port Phillip Survey: Areas 50 (230); 55 (intertidal). Nat. Mus. Coll.: Brighton (Area 7).

REMARKS: A shallow water species living under stones from low tide to several fathoms.

Family Mytilidae.

Modiolus cottoni (Laseron).

Modiolus cottoni Laseron, 1956. Aust. Zool., XII., pt. 3, p. 270, f. 25–8.

MATERIAL: Port Phillip Survey: Area 58 (—); 59 (23). Gabriel Coll.: Mornington (Area 55); Point Nepean (Area 58); Portsea (Area 58–9).

REMARKS: This species is found in small clumps on rock platforms at and below low tide. It appears to like clear water and is not very common in Port Phillip.

Modiolus inconstans (Dunker).

Volsella inconstans Dunker, 1856. Proc. Zool. Soc., p. 363.

Modiolus inconstans Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 286, f. 326.

MATERIAL: Port Phillip Survey: Areas 58 (89).

REMARKS: There are three species of intertidal and shallow water dwelling *Modiolus* (*M. inconstans*, *M. pulex* Lamarck, and *M. vexillum* Reeve) along the coast and penetrating the inlets of southern Australia. Because they are shallow water species they will not be considered in detail until the survey is extended to the littoral.

Dr. B. R. Wilson has made a detailed study of these species in the Swan River Estuary, W. Australia and indications are that the ecological conditions at the head of Hobson's Bay will make for a similar distribution.

Brachidontes rostratus (Dunker).

Mytilus rostratus Dunker, 1856. Proc. Zool. Soc., p. 358.

Brachidontes rostratus Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 289, f. 331.

MATERIAL: Nat. Mus. Coll.: Point Lonsdale, Queenscliff (Area 58); Point Nepean (Area 58); Portsea (Area 58–59); Sorrento (Area 59).

REMARKS: This species was not taken in the present survey as it is a littoral species living at mid-tide level. Also it is an inhabitant of open rocky coasts and does not penetrate Port Phillip beyond the Nepean Bay Bar.

Lanistina ulmus (Iredale).

Musculus ulmus Iredale, 1936. Rec. Aust. Mus., 19, p. 271, pl. 21, f. 10.

MATERIAL: Port Phillip Survey: Areas 11 (190); 31 (131); 39 (42); 58 (88). Nat. Mus. Coll.: Black Rock (Area 14); Brighton (Area 7); Frankston (Area 48).

REMARKS: This species lives in association with the Tunicate *Pyura praeputialis*.

Mytilus planulatus (Lamarck).

Mytilus planulatus Lamarck, 1819. Anim. s. Vert., 6, p. 125. Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 293, f. 335.

MATERIAL: Port Phillip Survey: Areas 3 (202); 5 (52–8, 165–9); 6 (63–7, 118, 137); 7 (123, 206, 208); 9 (62, 84, 178–80); 10 (11, 13–15, 103–4, 106); 11 (125); 12 (110–4); 13 (82, 92–4); 14 (175); 16 (142–3); 17 (170–1, 173); 18 (61, 308); 19 (179, 181, 306); 20 (124); 21 (115); 22 (119); 23 (68–70); 24 (122); 26 (127–8); 27 (41, 49, 138–9); 28 (140–1); 29 (174, 317); 30 (130, 132); 31 (10, 134–5); 35 (71–3); 36 (74–7); 37 (40–1); 39 (45–50); 42 (38, 107–9); 47 (29–30); 48 (34); 50 (230–1); 55 (144, 149); 56 (295); 59 (23, 79, 213); 61 (37); 62 (96); 63 (16–9, 21–2, 159–64); 68 (157).

REMARKS: Occurs in sheltered waters around the whole of the southern coast of Australia and in Tasmania. Like all members of the genus *Mytilus*, the larva require a solid substratum to settle on, this may be natural or man placed rock or wharf piling. Where such substratum is not available, advantage may be taken of even small solid objects such as stones, shells &c.

At stations where fine bottom sediments occur, adjacent to reefs and wharfs, clumps comprising a few large mussels are often found scattered over the sea floor. The individuals of these clumps are always large (individuals of one clump measured up to 7 inches in length) and obviously old. It is suggested that, as the shells become large and heavy they can no longer be supported by the byssus and so drop off to lie on the sea floor. Their large size enables them to lie on the top of the sediments and so survive under less favourable conditions.

Settlement of larva takes place at and below low water and only in areas where there is not excessive turbulence. In fact *Mytilus planulatus* is an inhabitant of bays and inlets and is not found on open coasts subject to the full force of oceanic conditions; though its ability to take advantage of even small areas of shelter is shown by its presence in the very small bay used as a boat loading at Wilson's Promontory lighthouse.

Family PTERIIDAE.

Electroma georgiana (Quoy and Gaimard).

Avicula georgiana Quoy and Gaimard, 1835. Voy. "*Astrolabe*". Zool., 3, p. 457, pl. 77, f. 10, 11.

MATERIAL: Port Phillip Survey: Areas 3 (202); 5 (168–9); 6 (137); 7 (208); 9 (178–80); 10 (13); 11 (190); 13 (92); 14 (175); 16 (142–3); 17 (170); 18 (59–60, 187, 306–7); 19 (178, 181); 20 (124); 22 (119); 26 (126–8); 27 (41); 28 (140); 29 (317); 31 (10, 132, 310); 34 (120); 37 (40); 39 (42–6, 311); 40 (101); 42 (108–9); 50 (230–1); 59 (36); 61 (37); 68 (156–7).

REMARKS: A widely distributed species in Port Phillip wherever algae or seaglasses occur to provide it with a suitable habitat and support. It seems likely that breeding occurs over most of the year as juveniles are always present on suitable attachment. In June 1959 at station 101 the *Cystophora uvifera* was covered with examples ranging in size from 1 to 10 mm. in width.

Family PECTINIDAE.

Propeamussium thetidis (Hedley).

Amusiam thetidis Hedley, 1902. Mem. Aust. Mus., 4, p. 304, f. 49.

MATERIAL: Port Phillip Survey: Area 42 intertidal; Gabriel Coll.: Ocean beach Point Nepean (Area 58).

Pecten alba (Tate).

Pecten alba Tate, 1886. Proc. roy. Tas., p. 114, Macpherson and Gabriel, 1962. Marine Mollusca of Victoria, p. 300, f. 341.

MATERIAL: Port Phillip Survey: Areas 5 (52, 166); 6 (63–4), 7 (207); 10 (11–13); 11 (125); 12 (111–2); 13 (92–3); 14 (175); 16 (142); 17 (170–1); 18 (59–61, 187–9, 306–8); 19 (304–6); 20 (124); 21 (176); 22 (119); 23 (68–70); 25 (129); 27 (47–8); 28 (315); 29 (174, 287, 317); 30 (130); 31 (10, 273, 276); 33 (177); 34 (120); 35 (71–2); 39 (45–8, 314); 43 (274); 47 (28–9, 31); 55 (144, 146, 255–6); 59 (25); 61 (242); 62 (96, 190–1, 243); 63 (159, 245–9); 68 (219); 69 (97, 100, 221–2).

REMARKS: Since the completion of the field studies of the present survey a commercial scallop fishery has commenced operation in Port Phillip. As stated in the introduction this was not a quantitative survey and this is not the place to try to assess the value or extent of the fishery. However, it is interesting to note that there are ecological differences in the occurrence of *Pecten meridionalis* in Tasmania and *Pecten alba* in Port Phillip, the only place where its ecology has been studied so far.

Pecten meridionalis occurs in the D'Entrecasteaux Channel in southern Tasmania as a pure community on a sandy bottom. Other animals and plants are few in species and those that do occur are very sparse. This is not the case in Port Phillip where *Pecten alba* is only one member of a rich community of which the other co-dominant species are the Ascidian *Pyura praeputialis* and, the Holothurian *Stichopus mollis*. Frequently the Ascidian *Microcosmos spiniferus* is found growing on the upper flat valve of the shell.

The exact relationships of the various so-called species round the southern Australian coast is not known, but they are in the process of being studied by A. M. Olsen and the present author and it is hoped to be able to discuss them in detail in a later paper.

It is interesting to note that the Fisheries and Wildlife Department estimate that approximately 94 million scallops have been taken from Port Phillip during the period September, 1963 to November, 1964.

Chlamys asperrimus (Lamarck).

Pecten asperrimus Lamarck, 1819. Anim. s. Vert., 6, p. 174.

Chlamys asperrimus Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 303, f. 344.

MATERIAL: Port Phillip Survey: Area 10 (14); 55 (148); 59 (24, 213); 64 (164). Nat. Mus. Coll.: Mordialloc (Area 24); Frankston (Area 48); Queenscliff (Area 58); Sorrento (Area 59).

REMARKS: This is a common species throughout Bass Strait and its occurrence in Port Phillip is practically limited to the southern end of the bay.

Family OSTREIDAE.

Ostrea angasi (Sowerby, 1871).

Ostrea angasi Sowerby, 1871. In Conch. Icon. (Reeve), 18, pl. 13, f. 27.

MATERIAL: Port Phillip Survey: Areas 5 (51–8, 166–9); 6 (63–4, 67, 118, 137); 7 (123); 10 (11, 12, 15, 103–4); 11 (125, 190); 12 (—); 13 (82, 92–4); 14 (117, 175); 16 (142–3); 17 (170, 172–3); 18 (59, 183, 187, 189, 307–8); 19 (306); 21 (115); 24 (122); 27 (41, 138–9); 28 (140–1, 315); 30 (130); 31 (10, 310); 34 (120); 35 (121); 36 (76–7); 39 (45–7); 40 (101); 42 (38, 107–9); 47 (29, 30); 48 (32); 55 (145–7); 61 (37); 62 (96); 63 (19, 21–2, 159, 161–4); 68 (158); 69 (97).

REMARKS: This species can withstand and cope with a considerable amount of suspended matter in the water. Though requiring a solid object for the spat to settle on initially, the object can be extremely small and is quickly outgrown by the oyster which then comes to lie directly on the soft sediments. It occurs in areas of silty sand and silty clay from low water to approximately eleven fathoms but is not found on the true clay of the southern central basin.

Family CARDITIDAE.

Venericardia bimaculata (Deshayes).

Cardita bimaculata Deshayes, 1852. Proc. Zool. Soc., p. 102, pl. 17, f. 4–5.

MATERIAL: Port Phillip Survey: Areas 13 (92); 14 (175); 51 (250). Nat. Mus. Coll.: Port Phillip.

Family CARDIIDAE.

Fulvia tenuiscostata (Lamarck, 1819).

Cardium tenuicostatum Lamarck, 1819. Anim. s. Vert., VI., pt. 1, p. 5, No. 5. Reeve 1844. Conch. Icon., 11, pl. 10, f. 50.

MATERIAL: Port Phillip Survey: Areas 9 (62); 10 (11); 11 (125, 190); 13 (92); 18 (61, 307); 20 (124); 23 (2, 7); 25 (128); 27 (49); 30 (130); 31 (135); 36 (77); 37 (40, 297); 39 (314); 55 (147, 256); 59 (36); 68 (147, 158); 69 (221–2). Nat. Mus. Coll.: Brighton (Area 7); Point Cook (Areas 5 and 11).

REMARKS: This species is common on the silty sand areas from approximately 2 to 5 fathoms in suitable habitats.

Family VENERIDAE.

Subfamily Dosiniinae.

Phacosoma coerulea (Reeve 1850).

Artemis coerulea Reeve, 1850. Conch. Icon., 6, pl. 4, f. 25.

MATERIAL: Port Phillip Survey: Area 36 (76). Nat. Mus. Coll.: Point Nepean; Queenscliff (Area 58).

REMARKS: The occurrence of this species north of the Nepean bay bar is worthy of note as it had previously only been recorded from the Heads area.

Phacosoma circinaria (Deshayes).

Dosinia circinaria Deshayes, 1853. Brit. Mus. Cat., p. 9–10, No. 14.

Phacosoma circinaria Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 340–1, f. 390.

MATERIAL: Nat. Mus. Coll.: South Melbourne (Area 2); Altona (Area 5); Mordialloc (Area 24); Frankston (Area 48); Dromana (Area 63); Portsea (Area 59); Queenscliff (Area 58).

REMARKS: This species is an inhabitant of shallow water sandy areas from approximately low tide to just over 1 fathom. Valves are fairly frequently washed up along the beaches of the above localities, but it was not taken in the present survey, which as already explained, has not yet been extended to the shallow water of less than 1 fathom.

Subfamily Meretricinae.

Notocallista kingii (Gray, 1827).

Cytherae kingii Gray, 1827. King's Survey Aust., 2. Appendix p. 476.

Notocallista kingii Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 343, f. 393.

MATERIAL: Port Phillip Survey: Areas 7 (206); 13 (92); 55 (35). Nat. Mus. Coll.: St. Kilda (Area 3); Brighton (Area 7); Frankston (Area 48); Dromana (Areas 63 and 70).

REMARKS: Lives below low tide to approximately 2 fathoms on a sandy substratum. A specimen from station 35 was being eaten by *Pleuroploca australasia*.

Subfamily Venerinae.

Chioneryx cardioides (Lamarck, 1818).

Erycina cardioides Lamarck, 1818. Anim. s. Vert., 5, p. 486.

Chioneryx cardioides Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 346, f. 397.

MATERIAL: Port Phillip Survey: Areas 3 (202); 7 (206, 208); 11 (190); 13 (94); 14 (175); 19 (304–6); 20 (124); 24 (122); 27 (139); 31 (131); 36 (76–7); 61 (240). Nat. Mus. Coll.: St. Kilda (Area 3); Sandringham (Areas 13–14); Frankston (Area 48); Off Point Cook (Areas 5 and 11).

REMARKS: Occurs where reef and sandy mud intermix so that the reef only protrudes slightly in patches above the soft sediments.

Tawera gallinula (Lamarck, 1818).

Venus gallinula Lamarck, 1818. Anim s. Vert., 5, p. 592.

Tawera gallinula Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 347, f. 398.

MATERIAL: Port Phillip Survey: Areas 3 (202); 59 (36); 64 (164). Nat. Mus. Coll.: Frankston (Area 48); Dromana (Area 63); Sorrento (Area 59); Portsea (Area 58).

Callanaitis disjecta (Perry, 1811).

Venus disjecta Perry, 1811. Conchology, pl, 58, f. 3.

MATERIAL: Port Phillip Survey, Area 10 (12); 11 (125); 12 (114); 13 (83, 92); 14 (175); 18 (307); 20 (309); 21 (115); 29 (174). Nat. Mus. Coll.: Port Melbourne (Area 2); Frankston (Area 48); Rosebud (Area 69); Rye (Area 68).

REMARKS: This species is an inhabitant of sandy mud from just below low tide approximately the 10-fathom line.

Eumarcia fumigata (Sowerby, 1853).

Venus fumigata Sowerby, 1853. Thes. Conch., 2, p. 737, pl. 159, f. 152–155.

MATERIAL: Port Phillip Survey: Areas 3 (202); 7 (206, 208); 9 (84); 10 (106); 48 (32). Nat. Mus. Coll.: South Melbourne (Area 2); St. Kilda (Area 3); Mordialloc (Area 24); Dromana (Area 103).

REMARKS: This is a shallow water species ranging from low tide to several fathoms but most common in less than 1 fathom where it occurs in great numbers in suitable locations. It is probably the most abundant species in the shallows of areas 2 and 3 and after storms, is washed up in great numbers.

Katelysia scalarina (Lamarck, 1818).

Venus scalarina Lamarck, 1818. Anim. s. Vert., 5, p. 599.

Katelysia scalarina Nielsen, 1964. Mem. Nat. Mus. Vict. No. 26, p. 222, pl. 1, f. 1–3.

MATERIAL: Port Phillip Survey: Areas 5 (167); 42 (38); 58 (89); 63 (163).

REMARKS: Occurs in areas of sand from low tide to several fathoms.

Katelysia rhytiphora (Lamy, 1935).

Katelysia rhytiphora Lamy, 1935. Bull. du Mus. Nat. d'Hist. Natur. Paris ser. 2, T. 7, No. 6, p. 357; Nielson 1964, Mem. Nat. Mus. Vict., No. 26, p. 233, pl. 2, f. 4–6.

MATERIAL: Port Phillip Survey: Areas 5 (56, 168); 6 (118); 9 (84); 10 (106); 17 (173); 19 (179); 27 (41); 37 (40); 42 (38, 108); 61 (37); 3 (202).

REMARKS: This species is an inhabitant of sandy mud, living buried in areas where creeping plants such as *Zostera* or *Caulerpa* bind the fine sediments. A few specimens of each species may overlap into the habitat of the other but these individuals are the exceptions.

Pullastra galactites (Lamarck, 1818).

Venus galactites Lamarck, 1818. Anim. s. Vert., 5, p. 599.

Pullastra galactites Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 356, f. 413.

MATERIAL: Area 5 (57–8); 6 (118); 9 (84); 13 (83); 27 (41); 30 (130); 37 (40); 42 (38); 47 (30); 68 (155). Nat. Mus. Coll.: St. Kilda (Area 3); Brighton (Area 7); Mordialloc (Area 24); Sorrento (Area 59).

REMARKS: Lives in coarse sand where stones or reef afford it some shelter.

Pullastra fabagella (Deshayes, 1853).

Tapes fabagella Deshayes, 1853. Brit. Mus. Cat., p. 182.

Pullastra fabagella Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 358, f. 414.

MATERIAL: Port Phillip Survey: Areas 7 (206); 9 (178, 180); 16 (143, 283); 19 (179, 181); 27 (41); 28 (285); 51 (250).

REMARKS: This species is less associated with reefs than the previous one and appears to favour slightly finer sediments.

Family DONACILLIDAE.

Donacilla nitida (Deshayes, 1854).

Mesodesma nitida Deshayes, 1854. Proc. Zool. Soc., p. 338.

Donacilla nitida Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 362, f. 420.

MATERIAL: Port Phillip Survey: Areas 10 (106); 48 (32). Nat. Mus. Coll.: South Melbourne (Area 2); Elwood (Area 7); Mordialloc (Area 24); Mornington (Area 55).

REMARKS: An inhabitant of sand banks at and below low tide mark. This species is very common on the sand banks at the sheltered northern end of the bay.

Family MACTRIDAE.

Notospisula trigonella (Lamarck, 1818).

Mactra trigonella Lamarck, 1818. Anim. s. Vert., V., p. 479.

Gnathodon parva, Petit, 1853. Journ. de Conch., 4, p. 358, pl. 13, f. 9, 10.

Spisula trigonella Lamy, 1917. Ibid., 63, p. 310–13.

MATERIAL: Port Phillip Survey: Area 3 (202); 7 (206); 9 (84); 10 (106); 11 (201); 16 (283). Nat. Mus. Coll.: Port Melbourne (Area 2); St. Kilda (Area 3).

REMARKS: This species is an inhabitant of sandy mud areas of still water and is very common at and below low water in Hobson's Bay. There has been considerable confusion in regard to the name to be applied to this species and authors have used both *trigonella* and *parva*. Iredale 1930 applied *trigonella* to the Western and retained *parva* for the eastern shells. However Lamy (1914), had already discussed the matter and stated that he had compared the Lamarck and Petit types and found that they were con-specific. Further, both Iredale and Cotton were mistaken in the type locality of *trigonella* which Lamarck records as " la baie des chiens marins " and is the original French designation for Shark Bay*. A review of literature and specimens available suggests that *trigonella* is a northern and eastern species ranging as far south as Port Phillip and in the west to Shark Bay.

* Voyage de L'Astrolabe 1826–29, D'Urville—Atlas. " Historique, Cart pour L'intelligence du Mémoire de M. le Capitaine D'Urville sur les Iles du Grand Ocean (Océanie)".

Notospisula cretacea (Angas, 1867).

Spisula cretacea Angas, 1867. Proc. Zool. Soc., p. 909, pl. 44, f. 6.

MATERIAL: Port Phillip Survey: Area 9 (84). Nat. Mus. Coll.: Port Melbourne (Area 2), St. Kilda (Area 3).

REMARKS: This species occupies a similar habitat to the previous one and occurs in association with it in south-eastern Australia. It is the southern representative of the genus and its range as indicated by the material available, is from northern N.S.W. to Perth in Western Australia. Cotton and Godfrey (Molluscs of South Australia, pt. 1, p. 275–6, 1938) misapplied the name *M. trigonella* to the elongate shell and also misquoted the type locality of *M. trigonella* as King George Sound. Lamarck records it as coming from Shark Bay, Western Australia.

Electromactra antecedens (Iredale).

Electromactra antecedens Iredale, 1930. Rec. Aust. Mus., 17, p. 401, pl. 44, f. 1–3.

MATERIAL: Port Phillip Survey: Area 9 (84). Nat. Mus. Coll.: South Melbourne (Area 2), St. Kilda (Area 3); Mordialloc (Area 24); Dromana (Area 63); Queenscliff (Area 58).

REMARKS: Lives in shallow water usually in less than 2 fathoms so was not taken on the present stage of the survey. Beach material indicates that it is common below low tide on the northern and east sides of the bay.

Soletellina biradiata (Wood).

Solen biradiata Wood, 1815. General Conch., p. 135, pl. 33, f. 1.

MATERIAL: Port Phillip Survey: Areas 63 (163); 64 (164). Nat. Mus. Coll.: Mornington (Area 55); Rosebud (Area 69); Sorrento (Area 59).

REMARKS: Lives buried in silty sand in shallow water from low tide to approximately 2 fathoms.

Soletellina donacioides (Reeve).

Soletellina donacioides Reeve, 1857. Conch. Icon., 10, pl. 3, f. 11.

MATERIAL: Port Phillip Survey: Area 63 (163). Nat. Mus. Coll.: Port Melbourne (Area 2); St. Kilda (Area 3), Sandringham (Area 13); Frankston (Area 48); Rosebud (Area 69).

REMARKS: Occupies a similar habitat to *biradiata* but material in the collection indicates that it may prefer a more sheltered and muddier situation to that species. The inshore survey will give more data on this.

Family SEMELIDAE.

Theora fragilis (A. Adams).

Neaera fragilis A. Adams, 1855. Proc. Zool. Soc. Lond., p. 226.

Theora fragilis Macpherson and Gabriel 1962, Marine Molluscs of Victoria, p. 374–5, f. 438.

MATERIAL: Port Phillip Survey: Area 20 (124); 26 (126); 39 (42); 40 (101). Nat. Mus. Coll.: Off Point Cook (Area 5 and 11).

REMARKS: Occurs in sandy mud and when present is usually in large numbers.

Family TELLINIDAE.

Pseudarcopagia victoriae (Gatliff and Gabriel).

Tellina victoriae Gatliff and Gabriel, 1914. Vict. Nat., 31, p. 83.
Pseudarcopagia victoriae Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 375, f. 439.

MATERIAL: Port Phillip Survey: Areas 6 (118); 27 (41). Nat Mus. Coll.: Mordialloc (Area 24); Frankston (Area 48); Point Lonsdale (Area 58).

Homalina deltoidalis (Lamarck, 1818).

Tellina deltoidalis Lamarck, 1818. Anim. s. Vert., 5, p. 532.
Homalina deltoidalis Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 377, f. 440.

MATERIAL: Port Phillip Survey: Areas 9 (84); 10 (106); 37 (40 296–7); 55 (end of Mornington jetty); 58 (89); 61 (37). Nat. Mus. Coll.: South Frankston (Area 48); Geelong (Area 37).

REMARKS: This species is an inhabitant of silt in very still water where it occurs in large numbers. It occurs in Port Phillip in small restricted communities in suitable locations.

Homalina mariae (Tenison Woods).

Tellina mariae Tenison Woods, 1876. Proc. roy. Soc. Tas., 1875, p. 162.
Homalina mariae Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 377–8, f. 441.

MATERIAL: Port Phillip Survey: Area 58 (89). Nat. Mus. Coll.: Portarlington (Area 29); Geelong (Area 37); off Point Cook (Area 5 and 11).

REMARKS: Occurring under similar conditions as *H. deltoidalis* and often associated with it.

Hiatella australis (Lamarck).

Corbula australis Lamarck, 1818. Anim. s. Vert., 5, p. 643.
Hiatella australis Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 379, f. 444.

MATERIAL: Port Phillip Survey: Areas 18 (61); 55 (14); 56 (295); 58 (88); 59 (23, 36). Nat. Mus. Coll.: Sorrento (Area 59).

REMARKS: A crypt dwelling species found buried in softer rocks such as limestone and iron stones.

Family GASTROCHAENIDAE.

Gastrochaena tasmanica (Tenison Woods).

Gastrochaena tasmanica Tenison Woods, 1876. Proc. roy Soc. Tas., 1875, p. 159; Macpherson and Gabriel 1962, Marine Molluscs of Victoria, p. 383, f. 448.

MATERIAL: Port Phillip Survey. Area 5 (54); 30 (130); 55 (147); 69 (off Macrae).

REMARKS: This species occurs in areas where the sand and shell bottom provide it with suitable means of attachment and material for cementing into the protective flask with which each animal surrounds itself. Apart from station 54, all specimens were taken in depth ranging from 33 to 40 feet.

Family PHOLADIDAE.

Pholas australasiae (Sowerby).

Pholas australasiae Sowerby, 1849. Thes. Conch., 2, p. 488, pl. 106, f. 73.

MATERIAL: Port Phillip Survey: Area 25 (129). Nat. Mus. Coll.: St. Kilda (Area 3); Point Cook (Area 5 and 10); Sandringham (Area 13 and 14); Queenscliff (Area 58).

REMARKS: This burrowing species is found wherever soft rock affords it a suitable substratum and it occurs from the sublittoral to approximately 2 fathoms. At station 129 it is present in large numbers, a single haul with a Peterson grab collected the siphons of about a dozen specimens. The grab only penetrated about 3 inches into the stiff consolidated mud and therefore cut the siphons off just above the buried shells. They are also common on the dipping offshore platforms of older basalt in Area 10.

Family MYOCHAMIDAE.

Myadora brevis (Sowerby).

Pandora brevis Sowerby, 1829. App. Stutchbury's Cat., p. 3, f. 2.

MATERIAL: Port Phillip Survey: Area 22 (119). Nat. Mus. Coll.: Port Melbourne (Area 2); St. Kilda (Area 3); Sandringham (Area 13); Altona (Area 5). Gabriel Coll.: Point Cook (Area 5 and 11).

REMARKS: This shell was only taken at the one station on the present survey but Gabriel records that he took it in large numbers in 8 fathoms off Point Cook.

Family CLEIDOTHAERIDAE.

Cleidothaerus albidus (Lamarck).

Chama albidus Lamarck, 1819. Anim. s. Vert., 6, p. 96.

Cleidothaerus albidus Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 395, f. 463.

MATERIAL: Port Phillip Survey: Area 5 (53); 14 (117, 175); 18 (59–60); 28 (141); 30 (130); 31 (10); 55 (148); 59 (36); 64 (164).

REMARKS: Previously only known as an infrequent wash up from deeper water the survey has shown it to be a common shell on the reefs in deeper water.

Family LATERNULIDAE.

Offadesma angasi (Crosse and Fischer).

Periploma angasi Crosse and Fischer, 1864. Journ. de Conch., 12, p. 349.

Offadesma angasi Macpherson and Gabriel, 1962. Marine Molluscs of Victoria, p. 399, f. 469.

MATERIAL: Port Phillip Survey: Area 13 (210); 43 (263). Nat. Mus. Coll.: Frankston (Area 48), Portarlington (Area 29); Off Point Cook (Area 5 and 11).

Laternula creccina (Reeve).

Anatina creccina Reeve, 1860. Conch. Icon., 14, pl. 2, f. 12.

MATERIAL: Port Phillip Survey: Area 9 (84); 61 (241). Nat. Mus. Coll.: Frankston (Area 48); Portarlington (Area 29); Off Point Cook (Area 5 and 11); Dromana (Area 63).

Class **CEPHALOPODA.**

On this present phase of the survey the cephalopods collected were mainly benthic living forms such as *Octopus*. However as a number of pelagic species are known to be quite common in Port Phillip it seems advisable to record them and so make the list as complete as possible.

Order **Decapoda.**

Family SEPIIDAE.

Amplisepia apama (Gray).

Sepia apama Gray, 1849. Ceph. Antep. Brit. Mus., p. 103; McCoy, 1888. Prodromus Zool. Vic., XIX., pl. 188, 189, 190.

MATERIAL: Nat. Mus. Coll.: Mordialloc (Area 24); Corio Bay (Area 25–6, 37–8); Point Lonsdale (Area 58); Portarlington (Area 39).

REMARKS: This is the largest and commonest squid in Victorian waters and is taken frequently by nets, long lines and when fishing from jetties. Because it is well known and used commercially as bait and as food particularly by the section of the population with a southern European origin, it is rarely brought into the museum and so the collections give no idea of its prevalence.

Euprymna tasmanica (Pfeffer).

Pl. 1, figs. 1–4.

Euprymna tasmanica Pfeffer, 1884. Ceph. Hamburg. Mus., p. 6, f. 7; Allan 1950, Australian Shells, p. 452.

MATERIAL: Port Phillip Survey: Area 37 (296–8); 59 (214). Nat. Mus. Coll.: Williamstown (Area 6); Altona (Area 5); Carrum (Area 36); Dromana (Area 63); Mordialloc (Area 24); Portarlington (Area 29); Point Henry (Area 26).

REMARKS: Allan suggests that this species and *E. stenodactyla* may be conspecific but appears to base her conclusions on overall appearance rather than specific constant characters. Because of this doubt as to whether the southern species was separable from the Indo–Pacific *E. stenodactyla*, Port Phillip specimens were considered in the light of Voss 1963 (Smithsonian Institution W. S. Nat. Mus. Bull. 234, p. 52–56), discussion of *E. stenodactyla*. He states that he has found that in malas "If one, . . . centres upon the size and arrangement of the arm suckers, some cohesion becomes apparent. I have examined specimens of *E. morsei* and *berryi* from Japan, and find that they consistently conform to the illustration and description given by Sasaki". It was found that in the Port Phillip specimen also, the size and arrangement of the arm suckers of the males was constant and fortunately the single specimen on which Pfeffer based his species was a male and he gave a detailed description of the suckers of the arms. The constant distinguishing feature as stated by Pfeffer and which occurs in the Port Phillip specimens is that there are two enlarged suckers 2 mm. ring diameter on the ventral side of the second and third pair of arms (Pl. I., fig. 3). This arrangement of suckers also occurs in all males in the Museum collection taken from Victorian waters outside Port Phillip. Thus it seems likely that this is the only representative of this genus in Victoria.

Family IDIOSEPIIDAE.

Idiospeius notoides (Berry).

Idiospeius notoides Berry, 1921. Rec. South Aust. Mus., vol. 1, p. 361–2, f. 67, Chart II.

MATERIAL: Port Phillip Survey: Area 42 (—); Area 68 (156). Nat. Mus. Coll.: Altona (Area 5); Portarlington (Area 29); Swan Bay (Areas 49–50); Rye (Area 68).

REMARKS: This small species originally described from Goolwa, S. Aust. has been overlooked and not recorded as an element of the Port Phillip fauna until now. However it is not uncommon and a check of the museum collections show that it was collected at Altona by Mrs. Freame in 1933 but was not identified and so not recorded.

Family OMMASTREPHIDAE.

Nototodarus sloanii gouldii (McCoy).

Ommastrephes gouldii McCoy, 1888. Prodormus of Zoology of Victoria, Decade 17, pp. 255–257, 10 pls.

Nototodarus sloanii (in part) Pfeffer, 1912. In Ergebnisse . . . der Plankton Exped. Humboldt and Stiftung, vol. 2, p. 000

Nototodarus gouldi Berry, 1918. Biological Results . . . F.I.S. Endeavour 1909–14, vol. 4, pt. 5, p. 000.

Nototodarus sloanii gouldii Dell, 1952. Dominion Mus. Bull. Wellington, No. 16, pp. 117–9.

MATERIAL: Nat. Mus. Coll.: Hobson Bay (Areas 2 and 3). Holotype and Paratype.

REMARKS: McCoy described *N. gouldi* from a specimen collected in Port Phillip and pointed out its close relationship to *Omnastrephes insignis* Gould (and *sloanii* Gray). Pfeffer also realizes the synonymy of *sloanii* but Berry (1918) retained its separate identity. Then Dell (1952) described the New Zealand form in detail and has shown that it is *sloanii* s.s., he distinguished it from the Australian form which he called *N. sloani gouldi*. Voss (1963) (Smithsonian Institution Bull., 234, pp. 129–1) discussed *sloanii* and its subspecies and recorded *sloanii gouldii* as the southern Australian form. He states: "there appears to be a distinct cline with the species *N. sloanii* following a curve from New Zealand through Australia, Philippines and Hawaii".

Family LOLIGINIDAE.

Sepioteuthis australis (Quoy and Gaimard).

Sepia australis Quoy and Gaimard, 1832. Voy. Astrolabe Zool., 2, p. 70, pl. 5, f. 3–7.

MATERIAL: Nat. Mus. Coll.: Corio Bay (Areas 25–6 and 37–8); Limeburner Point (Area 37).

REMARKS: This species together with *N. gouldii* and *L. etheridgei* are fished commercially in Victorian waters and are sold for food and bait.

Loligo sp.

Loligo etheridgei Berry, 1918. Biological Results, F. I. S. Endeavour, 1909–14, vol. 4, pt. 5, p. 243–249, pls. 67–68, 69, f. 1–2.

REMARKS: From time to time large numbers of small "squid" occur in Port Phillip. In general appearance they are very close to *L. etheridgei* but as all specimens so far examined are either female or immature males without the hectocotylized arm developed, I prefer to just record their presence until they can be studied further.

Order **OCTOPODA.**

Family OCTOPODIDAE.

Octopus pallidus (Hoyle).

Octopus boscii var. *pallida* Hoyle 1885, Ann. Mag. Nat. Hist., (5), XV., p. 222; Pritchard and Gatliff, 1898, Proc. roy Soc. Vict., n.s., X., p. 241.

Polypus variolatus Berry, 1918. Biol. Res., F. I. S. "Endeavour", 1909–14, (Commonwealth of Australia) IV., pt. 5, p. 278, pls. 79, 80, 81, f. 2, 3, 82, f. 1–4.

Octopus pallida Robson, 1929. A Monograph of the Recent Cephalopoda, pt. 1, Octopodinae, p. 126–128.

MATERIAL: Port Phillip Survey: Areas 23 (—); 24 (—); 31 (10); 36 (74); 64 (164). Nat. Mus. Coll.: Hobsons Bay (Area 3 and 4); Carrum Creek, (Area 36); Portarlington (Area 29); Beaumaris (Area 14); Queenscliff (Area 58–9); Port Melbourne (Area 3).

REMARKS: This species has been described in detail by Berry (1918) and Robson (1929). It is common on the shallow coastal waters of south-eastern Australia and inhabits the reefs of Port Phillip. Large specimens may be as much as 350 mm. in length. The body is stout and the impression is of a solidly built animal with thick arms and a rough textured skin. The texture is due to the closely set rosette-shaped tubercles which cover the body surface. Round the eyes some of the tubercles are prolonged into branched cirrhus.

Octopus australis (Hoyle).

Octopus australis Hoyle, 1885. Ann. Mag. Nat. Hist. (5), XV., p. 224; Hoyle 1886, Report . . . H.M.S. "Challenger" Zoology, vol. 16, pt. 44, p. 88, pl. 111, f. 4–5.

Octopus australis Pritchard and Gatliff, 1898. Proc. roy Soc. Vic., X., p. 241.

Polypus cf. australis Berry, 1918. Biol. Res. F. I. S. "Endeavour" 1909–14 (Commonwealth of Australia), IV., pt. 5, p. 276, pl. 78, f. 1–2, pl. 81, f. 1.

Octopus australis Robson, 1929. A Monograph of the Recent Cephalopods, pt. 1, Octopodinae, p. 144–145.

MATERIAL: Port Phillip Survey: Areas 23 (1); 31 (273); 55 (35). Nat. Mus. Coll.: Hobsons Bay (Area 2 and 3); Brighton Beach (Area 7); Cheltenham (Area 24); Mordialloc (Area 24); off Mt. Martha (Area 63); South Melbourne (Area 3); Beaumaris (Area 14).

REMARKS: This species is less common than *O. pallida* but has a similar habitat. It is a smaller species, the largest specimen taken in Port Phillip being 250 mm. The arm length is slightly greater than in *pallida* being about 75 per cent. in proportion to total length. The surface is covered with granular tubercles but unlike *pallida* they are simple and usually not as large. There are cirrha round the eyes. The living animal is greyish-fawn in colour and the ink red-brown.

Octopus flindersi (Cotton).

Pl. II., figs. 1–3.

Octopus flindersi Cotton, 1932. Records S. Australian Museum, vol. IV., No. 4, p. 543–544, f. 4–6.

MATERIAL: Nat. Mus. Coll.: Geelong (Area 37); Newport Power House (Area 2); Williamstown (Area 60); Mt. Martha (Area 63); Mordialloc (Area 24); Carrum (Area 36); Hobsons Bay (Area 2 and 3).

REMARKS: This species was not taken during the present survey of Port Phillip and as the few specimens (six) in the National Museum collection were collected over a long period from 1888 to 1956, it seems

likely that it is an infrequent visitor to Port Phillip. Cotton in the original description states " Common in south-east of South Australia during the summer ", and this is borne out by the present specimens which were all collected between December and May. As Cotton described only the female, a description based on specimens from Port Phillip follows and in Table 1 measurements of these specimens and the Holotype are given.

The measurements of the latter were made by Dr. Helene Laws, Curator of Invertebrates at the South Australian Museum. Because of the great difference in size between the Holotype and the Port Phillip specimens it is difficult to draw an exact comparison but the figures correspond closely enough to leave no doubt as to their relationship.

Description: Body sack-like, narrowest towards the junction with the head which is narrower than the body. The arms are long probably 80 per cent. of total length and in the order of 1234. The suckers are small averaging about 10 per cent. of mantle length. The web is shallow, usually about 15 per cent of arm length, the sectors subequal A and E usually being the shallowest.

Colour of preserved specimens dirty cream patterned with widely scattered small reddish granules.

The small series of specimens make it impossible to draw any conclusions on size differences between males and females. The hectocotylized arm is much shorter than its pair and the ligula which is between 7–9 per cent. of its length is deep and spoon-like. (Pl. II., fig. 3.)

Fig. 1.—Penis of *O. flindersi*, No. F 1516. x 3.

The penis has a flash-shaped distal tube and a long thin diverticulum running to the left side of the animal. (Fig. 1). As all the female specimens, apart from the type, are immature and poorly preserved, it is considered only misleading to describe the female organs. Cotton states that the funnel organ is W shaped but it was not definite in any of the National Museum specimens although glandular tissue was present.

TABLE I.

Registered Number and Sex	1. Total Length	2. Mantle Length	3. Width Index Percentage of 2	4. Interocular Index Percentage of 2	5. Arm Formula	6. Arm Length Percentage of 2	7. Number of Gill Filaments	8. Diameter of Suckers Percentage of 2	9. Web Formula	10. Web Depth Percentage of Arm	11. Hectocotylus Length of Ligula as Percentage of Arm
	mm.	mm.									
F1516 ♂	350	51	49	49	1234	83	9	9	Damaged equal	8	9
F5101 ♂	160	25	72	56	1234	70·5	..	12	BCDAE	14	5 immature
F24488 ♀	156	22	77	68	1234	82	..	7	BCDAE	15	..
F24505 ♂	275	55	43·5	34·5	1234	65·5	10	3	ABCDE	15	6.75 immature
D10169 ♀ (Holotype, S. Australian Museum.)	980	175	64	34	1234	77	..	14	..	21	..

Measurements of *Octopus flindersi* Cotton.

Octopus superciliosus (Quoy and Gaimard).

Pl. III., figs. 1–2; Pl. IV., figs. 1–4; Pl. V., figs. 1–4.

Octopus superciliosus Quoy and Gaimard, 1832. Voyage de L'Asbrolabe, Zoology, t. 2, p. 88, pl. 6, f. 4; d'Orbigny 1840, in Ferussac and d'Orbigny. Hist. Nat. des Cephalopodes, p. 41–2, pl. 10, f. 3, pl. 28, f. 9.

Octopus westerniensis d'Orbigny, 1840. Ibid., pl. 10, f. 3, legend of figures which are stated in explanation of figures in text to be "copie de la figure donée par Mr. Quoy, in le Voyage de l'Astrolabe" and which comparison shows to be correct.

Octopus superciliosus Robson, 1929. A Monograph of the Recent Cephalopoda, pt. 1, Octopodinae, p. 165–166

MATERIAL: Port Phillip Survey: Areas 37 (4); 47 (29); 58 ( ). Nat. Mus. Coll.: Hobsons Bay; Area 2 and 3, Brighton (Area 7); Mentone (Area 26); Elwood (Area 7); Black Rock (Area 14); Williamstown (Area 6); Chelsea (Area 24); Kerford-road Pier (Area 7); South Melbourne (Area 3); Queenscliff (Area 58–9); Cheltenham (Area 14); off Dromana in scallop beds (Area 62–3); Indented Heads (Area 42); Rosebud (Area 69); 2 miles S. W. of Mordialloc Pier (Area 24); Portsea Pier (Area 59); Western Beach, Corio Bay (Area 37); Newport Power House, Williamstown (Area 6); Western Port, Victoria.

REMARKS: The commonest Octopus collected in Port Phillip occurred on sandy mud bottoms between 2 and 5 fathoms in association with *Ostraea angasi* and *Pecten alba*. It was unlike any species recently recorded from South-eastern Australia but juvenile specimens appeared to resemble Quoy and Gaimard's description and figure of *O. superciliosus* from Western Port Bay.

According to Robson, the only record of this species is the type in the Museum Nationale d'Histoire Naturalle, Paris and this a juvenile female. In actual fact the "Astrolabe" collected three specimens and d'Orbigny selected the largest as type.

Two specimens of batch F24439 were sent to Paris for comparison with the "Astrolabe" material and later, Dr. J. Gaillard very generously made available first the smaller paratype and later the holotype for comparison with the Port Phillip specimens and with five specimens collected recently from Western Port by Mr. A. Gilmour of the Fisheries and Wildlife Department.

As this species has been known previously only from three juvenile, it was felt desirable to give a more detailed description of adult females and of the male and a table of measurements of a series to show the variations encountered. It will be seen from Table 2, individuals show considerable variation in body shape, tentacle length, etc., but viewed as a series they have the appearance of a homogeneous group.

Description: Living specimens are rich earth-brown in tone with a distinct colour pattern (Pl. III., figs. 1–2) which is lost completely on death. The response to stimulus such as a light flash is very rapid the body and tentacles contract instantly, the whole animal becomes darker in colour and the skin appears to be pustulose.

In preserved specimens the body is elongate oval, the width being approximately 50 per cent. of the mantle length. Well preserved specimens or those killed by immersion in formalin or rectified alcohol tend to be more contracted and therefore have a shorter body than relaxed or less well preserved specimens. The head is well defined but narrower than the body to which it is attached by a distinct neck, the eyes are prominent in most juveniles and less so in adults and also in relaxed specimens whether adult or juvenile.

TABLE 2.

Registered Number and Sex		1. Total Length	2. Mantle Length	3. Width Index Percentage of 2	4. Interocular Index Percentage of 2	5. Arm Formula	6. Arm Length Percentage of 1	7. Number of Gill Filaments	8. Diameter of Suckers Percentage of 2	9. Web Formula	10. Web Depth Percentage of Arm	11. Hectocotylized Length of Ligula of Aarm
		mm.	mm.									
F24439	(1) ♀	90	32	53	42	Equal	67	..	6	C DBEA	22	..
	(2) ♀	110	39	56	41	Abnormal	64	..	6	Abnormal	26	..
	(3) ♀	68	22	50	31·5	Equal	57	..	5·5	CDBEA	27	..
	(4) ♀	137	45	60	46	4321	53	8	8	DECBA	30	..
	(5) ♀	132	41	52·5	46	4321	64	8	7	DECBA	25	..
	(6) ♀	195	47	50	36	Equal	61·5	..	6·25	CDBEA	23·0	..
	(7) ♀	175	42	54·5	38	Sub-equal	71·5	9	7	CDBEA	21·5	..
	(8) ♂	200	58	53	34·5	Sub-equal 4321	60	8	7·75	CDEBA	17·5	13
	(9) ♂	210	55	49	34·5	Sub-equal 4321	66	..	7	CDBEA	25	13
F24437 ♀		250	87	34	24	4321	65	8	..	CDEBA	25	..
F24438 ♂		230	74	48	29	4321	60	..	..	CDBEA	32	17
F24441 ♀		260	78	43·5	34	Sub-equal	62	8	..	DCEBA	24·5	..
F24442 ♀		72	27	50	40	Sub-equal	57	8	..	DCEBA	34	..
F24438 ♀		210	58	45	45	Equal	66	8	..	DCEBA	23	..

Measurements of a series of specimens of *Octopus superciliosus* Hoyle in collection of National Museum of Victoria and the Holotype and Paratype III. Holotype. Paratypes and F 25228 from Western Port, Victoria, d'Orbigny mistakenly stated that the Holotype was a male.

TABLE 2.—*continued.*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Registered Number and Sex	Total Length	Mantle Length	Width Index Percentage of 2	Interocular Index Percentage of 2	Arm Formula	Arm Length Percentage [illegible]	Number of Gill Filaments	Diameter of Suckers Percentage of 2	Web Formula	Web Depth Percentage of Arm	Hectocotylized Length of Ligula of Aarm
F24486 ♂	210	47	59	44	Equal	67	8		CBDEA	24	15
F21911 ♂	240	62	48	29	3214 damaged	71		6	DCBEA	22	16
F24489 [illegible]	355	103	51	33	Equal	66	8	6	DECBA	22	
F25228 [illegible]	640	133	45	28.5	Sub-equal 4321	78		7 13 (enlarged)	CBDAE	21	
F25245 ♀	178	44	66	41	2314	64		7	BCDAE	20	
Holotype ♀	100	21	66	47	4213 Sub-equal	74	8	9	DCBEA	21	
Paratype III ♀	40	11	63	54	2341	80		9	DCBEA	28	

(M 4)

The arms are approximately equal in length and measurement is difficult without breaking the fine tips but the slight differences in lengths are usually in the order of from longest to shortest 4321, and are approximately 65 per cent. of total length. The suckers are evenly and widely spaced with an index of about 70 per cent. of mantle length. The typical pattern of the oral surface is shown in the Paratype (Pl. IV., fig. 5)

Fig. 2.—Funnel organ of *O. superciliosus*, No. F 21911. x 3.

and only one specimen, the largest (F 25228) from Western Port shows a gradation in the size of the sucker of each arm-pair, the largest being on the first pair. The web varies between 18–32 per cent. of arm length, sectors B. C. D. being approximately equal and E. and A. shallower in that order.

Fig. 3.—Ligula of hectocotylized arm of *O. superciliosus*, No. F 21911. x 3.

The body surface has a smooth appearance in life but preserved specimens, when viewed with a lens, may show simple small pustules in the head and neck region. A few cirrhi are scattered over the dorsal surface and there is usually a row of three on the dorsal side of each eye. The visibility of the cirrhi varies considerably from specimen to specimen,

in some specimens they stand up as much as a millimetre from the surface while in others they are only indicated by dimple from which they can be made to protrude by pressure. The form of individual cirrhus also varies some are simple, while others are branched.

Fig. 4. Penis of *O. superciliosus*, No. F 21911. x 3.

The colour in preserved specimens varies considerably, in many it is grey with a mauve tint on the dorsal surface fading to pale grey on the ventral side. In others the dorsal surface may be purple black.

Fig. 5. Oviduct and gland of immature ♀ of *O. superciliosus*, No. F 24439. x 3.

The pallial-aperture is moderately wide (B B–C). The funnel extends half-way up the web and is free for half its length. The funnel organ is either absent or very faint in most specimens so that only portion of it is discernible as a suggestion of differentiated glandular tissue. In

specimens where it is complete (Fig. 2) it is in the form of two closely situated V's with broad petalshaped limbs, the laterals being the shorter. There are 8 or 9 gill filaments.

The radula has a rhadchidian tooth with a long sharp central cusp with two or three small ectocones on each side. In F 25228, which has three ectocones, they did not appear to be in series and are symmetrical. The other four radulae examined were all asymmetrical and the position and number of the ectocones was not constant. Specimen No. F 24441 had the Robson formula B, two teeth had two ectones followed by two teeth with only one.

In contrast to the variation in the rhachidian teeth, the laterals and marginals appeared to be very constant in form. The first lateral has a straight base with a high pointed ectocone and a small cusp on the inner side. The second lateral has a slightly curved base with a large mesocone arising from the inner margin of the tooth and a small entocone on the outer margin. The third lateral is long strong and slender with a stout curved base. The marginal is oblong with a curved inner margin that appears to correspond to the curved head of the third lateral.

Fig. 6.—Oviduct and gland of gravid ♀ of *O. superciliosus*, No. F 25245. x 3.

There is no external differentiation of males and females apart from the hectocotylized arm which is slightly shorter than its pair, the ligula Fig. 3) being 13–15 per cent. of its length, leaf-shaped without an obvious groove. The penis (Fig. 4) has a large bent diverticulum and a thick distal tube.

The paired oviducts are long and thin (Fig. 5) in most specimens with the oviduct gland showing as only a slight distension towards the coiled basal portion of the duct. In gravid females the oviduct becomes swollen and the basal coils unwind so that the gland which also distends and darkens in colour is very well differentiated from the white duct (Fig. 5). The eggs are laid in clusters in an opened oyster or scallop shell (Pl. III., fig. 2) and the female broods them. They are sausage-shaped with one end of each capsule drawn out into a stalk and knotted with those of the other capsules to form a tassel-like cluster. The eggs are large 12 mms. long by 5 mm. wide.

Hapalochlaena maculosa (Hoyle).

Octopus pictus Brock, 1882, (non Blainville, 1828). Anatomie und Systematik de Cephalopoden Z. Wiss. Zool., Leipzig, 36, p. 603, pl. 37, f. 3.

Octopus maculosus Hoyle, 1883. Proc. Phys. Soc. Edin., VII., p. 319, pl. VI.

Haplochlaena maculosa Robson, 1929. A Monograph of the Recent Cephalopoda, pt. 1, Octopodinae, p. 211–214.

MATERIAL: Port Phillip Survey: Area 64 (164); Area 55 (147); Area 30 (135).

REMARKS: A small Octopus immediately separated from any other southern species by the distinctive coloration of a yellowish ochre ground patterned with dark maculation on which there are rings of brilliant irridescent deep blue.

It occurs in Port Phillip from low tide to approximately 5 fathoms and prefers a habitat with a sandy bottom where small rocks or larger shells such as scallops and oysters provide shelter. The eggs are laid in shells and brooded by the female. It has come into prominance in the last few years because of its quite potent venom which causes paralysis in man. Fortunately it is a rather sluggish species and not easily aroused, so bites are infrequent. Dr. S. and W. Freeman of University of Melbourne are currently making a study of the venom and hope to be able to elucidate its components.

Family ARGONAUTIDAE.

Argonauta nodosa (Solander).

Argonauta nodosa Solander, 1786. Cat. Portland Mus., p. 96; Macpherson and Gabriel 1962, Marine Molluscs of Victoria, p. 417–8, f. 486.

MATERIAL: Nat. Mus. Coll.: Brighton (Area 7); Altona (Area 5, 10).

REMARKS: Schools of this open ocean species occasionally drift into Port Phillip and become stranded on bayside beaches.

SPECIES RECORDED FROM PORT PHILLIP BUT NOT TAKEN ON THE PRESENT SURVEY.

There are approximately 260 species recorded from Port Phillip but not taken on the present survey. Of these 80 species were recorded without locality other than Port Phillip and 129 are only known from south of the Nepean Bay Bar, most localities being in the vicinity of Port Phillip Heads. The remaining 51 species are either small and rare and therefore easily missed or are littoral forms not within reach of the present collecting methods.

Class **AMIPHEURA.**

Family LEPIDOPLEURIDAE.

Parachiton profundis (May, 1923), off Point Cook in 8 fathoms (Areas 5 and 11). Bednall recorded *Terenochiton liratus* from Hobson's Bay but it seems likely that he misidentified this species.

Family LEPIDOCHITONIDAE.

Acutaplax rufa (Ashby, 1900), Port Phillip Heads (Area 58).

Family CRYPTOPLACIDAE.

Craspedoplax cornuta (Toor and Ashby, 1898), Sorrento (Area 59).
Notoplax speciosa H. Adams, 1861.
Notoplax rubrostratus (Torr, 1913), Sorrento 5 fathoms (Area 59).
Bassethullia matthewsi (Pilsbry, 1894), Port Phillip Heads (Area 58).
Bassethullia glypta (Sykes, 1896), Port Phillip Heads (Area 58).
Acanthochiton gatliffi Ashby, 1919, Port Phillip.
Acanthochiton pilsbryi Sykes, 1896, Portsea Pier (Area 59).
Acanthochiton sueruii (Blainville, 1825), Hobsons Bay (Area 2 and 3).
Acanthochiton wilsoni Sykes, 1896, Port Phillip Heads (Area 58).

Family ISCHNOCHITONIDAE.

Autochiton torei (Iredale and May, 1924).
Autochiton wilsoni (Sykes, 1896), Port Phillip Heads (Area 58).
Haploplax pura (Sykes, 1896), Port Phillip Heads (Area 58).
Stenochiton longicymba Blainville, 1825, Port Phillip Heads (Area 58).
Stenochiton pallens Ashby, 1900, Port Phillip Heads (Area 58).

Family CHITONIDAE.

Rhyssoplax bednalli (Pilsbry, 1895), Port Phillip Heads.

Class **GASTROPODA.**

Family SCISSURELLIDAE.

Schismope atkinsoni (Tenison Wood, 1876), Portarlington (Area 29).
Scissurella remota Iredale, 1924, Point Nepean (Area 58).

Family FISSURELLIDAE.

Scutus antipodes Montfort, 1810, Sorrento (Area 59), Portsea (Area 58), Queenscliff (Area 58).
Tugali parmophoidea (Quoy and Gaimard, 1834).
Tugali cicatricosa A. Adams, 1857, Half Moon Bay (Area 24).
Notomella dilecta (A. Adams, 1851), see comments under *N. candida*, in body of paper.
Macroschisma tasmaniae Sowerby, 1866, Portsea (Area 58–9).
Macroschisma producta A. Adams, 1850, Sorrento (Area 59).

Family PATELLIDAE.

Patellanax peroni (Blainville, 1825), Sorrento (Area 59).
Patellanax chapmani Tenison Woods, 1876.

Family ACMAEIDAE.

Patelloida latistrigata Angas, 1865.
Notoacmea petterdi (Tenison Woods, 1876), Popes Eye (Area 59 (36).)

Family TROCHIDAE.

Herpetopoma scabriuscula Angas, 1867.
Gibbula (Notogibbula) coxi Angas, 1867, Portsea (Area 58–9).
Minopa brazieri (Angas, 1871).
Minopa petterdi (Crosse, 1870).
Leiopyrga octona Tate, 1891, Frankston (Area 48).
Astele subcarinatum Swainson, 1854, off Portsea. Area 58–9.
Austrocochlea concamerata (Wood, 1828), Point Nepean (Area 58) Queenscliff Area 58).
Clanculus (Macroclanculus) undatus (Lamarck, 1816), Sorrento (Area 59), Point Nepean (Area 58), Point Lonsdale (Area 58).
Spectomen philippiensis (Watson, 1881), off Port Phillip (Area 58).
Nanula tasmanica (Petterd, 1877).
Cirsonella translucida May, 1915, Portsea (Area 58–9).
Cirsonella weldii (Tenison Woods, 1877), Sorrento (Area 59).
Lodderena minima (Tenison Woods, 1878).
Elachorbis harriettai (Petterd, 1884).
Callomphala lucida (Ads. and Angas, 1864), Ocean beach Point Nepean (Area 58).
Crossea concinna Angas, 1867.

Family CYCLOSTREMATIDAE.

Zalipais inscripta Tate, 1899.
Brookula nepeanensis (Gatliff, 1906), Port Phillip Heads (Area 58).
Cithna flexuosa (Gould, 1861).

Family TURBINIDAE.

Munditia australis (Kienen, 1839), Sorrento (Area 59).
Argilista rosea (Tenison Woods, 1876), Sorrento (Area 59).
Subninella gruneri (Philippi, 1846), Sorrento (Area 59).
Phasianella variegata Lamarck, 1822.
Gabrielona nepeanensis Gatliff and Gabriel, 1908, Point Nepean (Area 58).

Family LITTORINIDAE.

Laevilitorina mariae (Tenison Woods, 1875).

Family RISSOIDAE.

Lironoba agnewi (Tenison Woods, 1876), Portsea (Area 58–9).
Pisinna bicolor (Petterd, 1884), Portsea (Area 58–9).
Pisinna frenchiensis (Gatliff and Gabriel, 1908), Sorrento (Area 59).
Pisinna olivacea (Frauenfeld, 1867), Sorrento (Area 59).
Pisinna subfusca (Hutton, 1873), Portsea (Area 58–9).
Notoscrobs petterdi (Brazier 1894), Sorrento (Area 58–9).
Merelina cheilostoma (Tenison Woods, 1876).
Merelina hulliana (Tate, 1893).
Rissoina d'orbignyi (A. Adams, 1851).
Rissoina elegantula Angas, 1880.
Rissoina rhyllensis Gatliff and Gabriel, 1908, ocean beach, Point Nepean (Area 58).
Anabathron contabulatum Frauenfeld, 1867, Sorrento (Area 59).
Eatoniella flammae (Frauenfeld, 1867), Portsea (Area 58–9).
Eatoniella melanchroma (Tate, 1899).
Tatea rufilalabris (A. Adams, 1862), Frankston Creek (Area 48).

Family TORNIDAE.

Cochliolepas angasi (A. Adams, 1863), Portsea (Area 58–9).
Cochliolepas vincentiana (Angas, 1880), Portsea (Area 58–9).
Pseudoliotia micans (A. Adams, 1850).

Family RISSOELLIDAE.

Jeffreysiella wilfredi Gatliff and Gabriel, 1911, ocean beach, Point Nepean (Area 58).

Family TURRITELLIDAE.

Gazameda gunni (Reeve, 1849), Point Nepean (Area 58).

Family SOLARIIDAE.

Philippia lutea (Lamarck, 1822), Barwon Heads (Area 56); Portsea (Area 58–9).

Family SILIQUARIIDAE.

Pyxipoma weldii (Tenison Woods, 1875).
Siliquaria australis (Quoy and Gaimard, 1834), Point Nepean (Area 58).

Family CAECIDAE.

Caecum amputatum Hedley, 1893, ocean beach, Point Nepean (Area 58).

Family CERITHIIDAE.

Diala magna Tate, 1891, deep water, Port Phillip.
Cacazeliana icarus Boyle, 1880, Portsea (Area 59).
Eubittium insculptum Reeve, 1865.
Batillariella estuarina (Tate, 1893).

Family CERITHIOPSIDAE.

Seila crocea (Angas, 1871).
Seila albosuturas (Tenison Woods, 1876).
Joculator cessicus Hedley, 1905.
Seilarex attenuatus Hedley, 1900, ocean beach, Point Nepean (Area 59).

Family Triphoridae.

Notosinister ampulla (Hedley, 1903), Portsea (Area 59).
Notosinister armillata (Verco, 1909), ocean beach, Portsea (Area 66).
Notosinister festiva (A. Adams, 1851), Portsea (Area 59).
Notosinister mammillata (Verco, 1909), Portsea (Area 59).
Notosinister pfeifferi (Crosse and Fischer, 1865), Sorrento (Area 59).
Notosinister robusta Laseron, 1954, Portarlington (Area 29).
Eutriphora cana (Verco, 1909), Portsea (Area 59).
Eutriphora tasmanica (Tenison Woods, 1876), Sorrento (Area 59).

Family Epitonidae.

Granuliscala granosa (Quoy and Gaimard, 1834), Frankston (Area 48); Dromana (Area 63, 70); Portsea (Area 58–9); Queenscliff (Area 58).
Opalia australis (Lamarck, 1822), distribution same as previous species.
Clathrus jukesiana (Forbes, 1852), Portsea (Area 59).
Propescala translucida (Gatliff, 1906), Portsea (Area 59).

Family Aclididae.

Coenaculum minutulum (Tate and May, 1900).

Family Melanellidae.

Melanella augur (Angas, 1865).
Melanella mucronata Reeve, 1866.
Melanella schontonica (May, 1915), Portsea (Area 59).
Melanella tenisoni Tryon, 1886.
Melanella tyroni Tate and May, 1900, Frankston (Area 48); Dromana (Area 63, 70).
Strombiformis acutissima (Reeve, 1866).
Strombiformis joshuana (Gatliff and Gabriel, 1910), Portsea (Area 58–9).

Family Pyramidellidae.

Syrnola tincta Angas, 1871, Barwon Heads (Area 56).
Syrnola bifasciata Tenison Woods, 1875.
Puposyrnola harrisoni (Tate and May, 1900), Portsea (Area 58, 59).
Agatha australis (Angas, 1871).
Agatha laevis (Angas, 1867), Dromana (Area 63, 70).
Odostomea occultidens May, 1915, Portsea (Area 58, 59).
Egilia mayii (Tate, 1898), Portsea (Area 58, 59)
Linopyrga portseaensis (Gatliff and Gabriel, 1911), Portsea (Area 58, 59).
Miralda suprasculpta (Tenison Woods, 1877), Portsea (Area 58, 59).
Cinctiuga diaphana Verco, 1906, ocean beach, Point Nepean (Area 58, 59, 66).
Chemnitzia acicularis (A. Adams, 1853), Portsea (Area 58–9).
Chemnitzia hofmani Angas, 1877, Barwon Heads (Area 56).
Chemnitzia mariae Tenison Woods, 1876.
Pyriguscus fusca (A. Adams, 1853).
Eulimella moniliformis Hedley and Musson, 1891, Swan Bay (Area 49, 50).
Eulimella birrita (Petterd, 1884), Swan Bay (Area 49, 50); Portsea (Area 59).
Oscilla tasmanica (Tenison Woods, 1876), Portsea (Area 58–9).
Pseudorissoina tasmanica (Tenison Woods, 1876), Portsea (Area 59).

Family Stiliferidae.

Stilifer lodderae Petterd, 1884.
Stilifer auricula (Hedley, 1907), ocean beach, Point Nepean (Area 59, 66).

Family Vanikoridae.

Vanikoro quoyiana A. Adams, 1853, Hobsons Bay (Area 2, 3).

Family Hipponicidae.

Antisabia foliacea (Quoy and Gaimard, 1835).

Family Calyptraeidae.

Sigapatella calyptraeformis (Lamarck, 1822), Point Cook (Area 5).
Crepidula aculeata (Gmelin, 1791). This New South Wales species seems a doubtful record as the more intensive collecting of recent years has failed to find it again.

Family NATICIDAE.

Conuber sordidum (Swainson, 1821). This species like *C. conicum* is an inhabitant of intertidal flats and shallow water but prefers quieter water with sandy mud substratum such as Hobson's Bay (Area 2 and 3).
Tanea sagittata (Menke, 1843).

Family LAMELLARIIDAE.

Mysticoncha wilsoni (Smith, 1886), Port Phillip Heads, dredged (Area 58–9).

Family CYPRAEIDAE.

Notocypraea piperita (Gray, 1825).
Ellatrivia merces (Iredale, 1924).
Ellatrivia oryza (Lamarck, 1810). The single MacGillivray record of this species from Port Phillip has not been confirmed and the record seems very doubtful.

Family CASSIDIDAE.

Antephalium semigranosum Lamarck, 1822, Mornington (Area 55); Sorrento (Area 59); Portsea (Area 58); Queenscliff (Area 58). Although once not uncommon in Port Phillip neither the Port Phillip survey nor recent active collecting by skin divers have produced specimens of this species.
Xenogalea spectabilis Iredale, 1929, Queenscliff (Area 58).

Family CYMATIIDAE.

Ratifusus mestayerae (Iredale, 1914).
Ratifusus bednalli (Brazier, 1875).

Family MURICIDAE.

Tornamurex denudatus (Perry, 1811), Port Melbourne (Area 2); Port Phillip Heads (Area 58). This species is uncommon in Port Phillip and was not taken on the present survey. The Port Melbourne record is an early one, it has not been taken at the northern end of the bay for many years.
Murexsul brazieri (Angas, 1817), Port Melbourne (Area 2).
Pterynotus angasi (Crosse, 1863), dredged off Altona (Area 5).
Litozamia brazieri (Tenison Woods, 1875), Sandringham (Area 13).
Litozamia goldsteini (Tenison Woods, 1875), Port Phillip Heads (Area 58–9).
Benthoxystus petterdi (Crosse, 1870).
Typhis philippensis (Watson, 1886), off entrance to Port Phillip (Area 58).
Lepsiella reticulata (Blainville, 1832).
Agnewia tritoniformis (Blainville, 1832).
Dicathais baileyana (Tenison Woods, 1881), Mornington (Area 55).

Family MAGILIDAE.

Liniaxis wilsoni (Pritchard and Gatliff, 1898), Point Lonsdale (Area 58).

Family COLUMBELLIDAE.

Zela beddomei (Petterd, 1884), Barwon Heads (Area 56).
Zela atkinsoni (Tenison Woods, 1875), Outer Harbour Geelong (Area 25–6).

Family BUCCINIDAE.

Phos senticosus (Linne, 1758), dredge Port Phillip Heads (Area 58).
Cominella kingicola Tate and May, 1900, Queenscliff (Area 58.
Tasmenthria clarkei (Tenison Woods, 1875).

Family NASSIDAE.

Alectrion particeps Hedley, 1915, Portarlington (Area 29).
Recticunassa compacta (Angas, 1865).

Family FASCIOLARIIDAE.

Propefusus pyrulatus Reeve, 1847, South Melbourne–St. Kilda (Area 3); Frankston (Area 48); Point Nepean (Area 58–9); Outer Harbour Geelong (Area 26, 38).

Family Olividae.

Cupidoliva nympha (Adams and Angas, 1863).
Alocospira edithae (Pritchard and Gatliff, 1898), Rosebud (Area 69); Sorrento (Area 59).

Family Mitridae.

Austromitra legrandi (Tenison Woods, 1875).
Austromitra schomburgki (Angas, 1878).
Austromitra tatei (Angas, 1878).
Eurmitra badia (Reeve, 1845), Frankston (Area 48); Sorrento (Area 59); Point Nepean; Queenscliff (Area 58).
Eumitra perksi (Verco, 1908).

Family Volutidae.

Lyrea mitraeformis (Lamarck, 1804), Point Nepean, Point Lonsdale (Area 58–9).
Ericusa sowerbyi (Kiener, 1839), Point Nepean, Point Lonsdale (Area 58–9).

Family Cancellariidae.

Sydaphera granosa (Sowerby, 1832), Point Nepean, Point Lonsdale (Area 58–9).

Family Marginellidae.

Cryptospira agapeta Watson, 1886, Portsea (Area 59).
Cryptospira subbulbosa Tate, 1878, Portsea (Area 59).
Cloisia whani (Pritchard and Gatliff, 1900), Carrum (Area 36).
Microginella cymbalum (Aate, 1878).
Euliginella angasi (Crosse, 1870).
Mesoginella turbinata (Sowerby, 1846).
Deviginella victoriae (Gatliff and Gabriel, 1908), Portsea (Area 59).
Austroginella tasmanica (Tenison Woods, 1875).

Family Turridae.

Austrodrillia beraudiana (Crosse, 1863).
Etrema denseplicata (Dunker, 1871).
Guraleus cuspis (Sowerby, 1896).
Guraleus incrustus (Tenison Woods, 1876).
Guraleus vincentinus (Crosse and Fischer, 1865).
Euguraleus lallemantianus (Crosse and Fischer, 1865).
Marita bella (Adams and Angas, 1863).
Marita compta (Adams and Angas, 1863), Sorrento (Area 59).
Paramontana modesta (Angas, 1877).
Paramontana tincta (Reeve, 1846).
Paramontana trachys (Tenison Wood, 1877), Brighton (Area 7).
Macteola anomala (Angas, 1877).
Asperdaphne desalesii (Tenison Wood, 1876), Sorrento (Area 59).
Eximilus teleoscopealis (Verco, 1896), Portsea (Area 58–9).
Nepotilla excavata (Gatliff 1906), ocean beach Portsea; Point Nepean (Area 58–9).

Family Conidae.

Floroconus segravei (Gatliff, 1890), off Portsea (Area 58–9).

Family Terebridae.

Nototerebra albida (Gray, 1834), Point Lonsdale; Nepean (Area 58), Portsea (Area 58–9).
Pervicacia ustulata (Deshayes, 1857), Point Lonsdale, Point Nepean (Area 58); Portsea (Area 58–9).
Pervicacia kieneri (Deshayes, 1859).
Pervicacia bicolor (Angas, 1867), Portsea (Area 58–9).

Family Ellobiidae.

Marinula zanthostoma H. and A. Adams, 1854, Frankston (Area 48).
Ophicardelus ornatus (Ferussac, 1821), Williamstown (Area 2, 6).
Leuconopsis pellucidus (Cooper, 1814), Frankston (Area 48); Portsea (Area 58–9).

Family GADINIIDAE.

Gadinia conica Angas, 1867, Portsea (Area 58–9).

Family SIPHONARIIDAE.

Siphonaria tasmanica (Tenison Woods, 1876), Sorrento (Area 59).
Siphonaria funiculata Reeve, 1856.
Siphonaria baconi Reeve, 1856, Sorrento (Area 59).
Pugillaria stowae (Verco, 1906), Portsea (Area 58–9).

Family ONCHIDIIDAE.

Onchidella patelloides (Quoy and Gaimard, 1832).

Class **BIVALVIA.**

Family LEDIDAE.

Scaeoleda crassa (Hinds, 1843), off Port Phillip 33 faths. (Area 58).
Propeleda ensicula (Angas, 1877), off Port Phillip 33 faths. (Area 58).

Family GLYCYMERIDAE.

Tucetilla striatularis (Lamarck, 1819).
Tucetilla radians (Lamarck, 1819), Point Nepean, Portsea (Area 58–9).

Family LIMOPSIDAE.

Philobrya fimbriata (Tate, 1898), Port Phillip Heads (Area 58).
Notomytilus rubra (Hedley, 1904), Portsea (Area 58–9).
Micromytilus crenatuliferus (Tate, 1892), Barwon Heads (Area 56).

Family MYTILIDAE.

Modiolus albicostus (Lamarck, 1819), Point Lonsdale (Area 58); Portsea (Area 58–9).
Gregariella barbatus Reeve, 1858, Frankston (Area 48); ocean beach, Portsea (Area 58–9).

Family VULSELLIDAE.

Vulsella spongiarum Lamarch, 1819.

Family PINNIDAE.

Atrina tasmanica (Tenison Woods, 1875), Queenscliff–Point Lonsdale (Area 58); Sorrento (Area 59).

Family PECTINIDAE.

Cyclopecten favus Hedley, 1902, Point Nepean (Area 58).
Camptonectes famigerator (Iredale, 1925), off Portsea (Area 58).
Chlamys atkinos (Petterd, 1886), Sorrento (Area 59).
Mesopeplum caroli Iredale, 1929, ocean beach, Point Nepean (Area 59, 66).
Mesopeplum tasmanicum (A. Adams and Angas, 1863).

Family LIMIDAE.

Limatula strangei (Sowerby, 1872), Portsea (Area 59).
Promantellus orientalis (A. Adams and Reeve, 1850), ocean beach, Point Nepean (Area 59, 66).

Family TRIGONIIDAE.

Neotrigonia margaritacea (Lamarck, 1804), dredged off Point Nepean (Area 58).

Family CARDITIDAE.

Cardita crassicostata Lamarck, 1819, ocean beach, Sorrento (Area 66).
Cardita excavata Deshayes, 1852 (=*C. calyculata* of authors non Linné) ocean beach, Sorrento (Area 66).

Family CONDYLOCARDIIDAE.

Carditellona angasi (Smith, 1885), Port Phillip Heads (Area 58).
Condylocardia crassicostata Bernard, 1896, Frankston (Area 48).
Benthocardiella chapmani (Gatliff and Gabriel, 1912), Portsea (Area 59); ocean beach Point Nepean (Area 58).

Family CYAMIIDAE.

Cyamiomactra balaustina (Gould, 1881), Portsea (Area 58–9).
Cyamiomactra mactroides (Tate and May, 1900).

Family GAIMARIIDAE.

Neogaimardia rostellata (Tate, 1888), Barwon Heads (Area 56).
Neogaimardia tasmanica (Beddome, 1882), Portsea (Area 59).

Family UNGULINIDAE.

Diplodonta globularis (Lamarck, 1818), off Point Cook (Area 5 and 11).
Diplodonta globulosa A. Adams, 1855, off Portsea (Area 59); off Point Cook (Area 5 and 11).
Diplodonta sublateralis A. E. Smith, 1884, off Point Cook (Area 5 and 11).
Numella adamsi (Angas, 1867).

Family LUCINIDAE.

Myrtea botanica (Hedley, 1917), Frankston (Area 48).
Myrtea mayi (Gatliff and Gabriel, 1911), off Point Cook (Area 5 and 11).
Divalucina cumingi (A. Adams and Angas, 1863).
Wallucina assimilis (Angas, 1867), Frankston (Area 48; Point Nepean (Area 58).
Epicodakia minima (Tenison Woods, 1875), Point Nepean (Area 58).
Epicodakia perobliqua (Tate, 1892), Point Nepean (Area 58).

Family ERYCINIDAE.

Kellia australis (Lamarch, 1818), off Portsea, Queenscliff (Area 58).
Melliteryx helmsi Hedley, 1915.
Bornia trigonale (Tate, 1879).
Lepton australis Angas, 1878, Sorrento (Area 59).
Lepton ovatum Tate, 1886, Portsea (Area 59).
Notolepton antipodium (Filhol, 1880), Port Phillip Heads (Area 58).
Notolepton sanguineum (Hutton, 1884), ocean beach, Point Nepean (Area 58).
Myllita deshayesi d'Orbigny and Reculz, 1850, Sorrento (Area 59).

Family MONTACUTIDAE.

Mysella anomala Angas, 1875, off Point Cook (Area 5 and 11); off Mornington (Area 55).
Mysella dromanaensis (Gatliff and Gabriel, 1912), Dromana (Area 63 and 70).
Montacuta semiradiata Tate, 1889.

Family CARDIIDAE.

Regozara cygnora (Deshayes, 1854), Carrum (Area 36); Portsea (Area 58–9).
Pratulum thetidis Hedley, 1902, Portsea (Area 58–9).

Family VENERIDAE.

Kerria victoriae (Gatliff and Gabriel, 1914), off Portsea (Area 58).
Notocallista disrupta (Sowerby, 1853), Port Phillip Heads (Area 58).
Tawera lagopus (Lamarck, 1818), Portsea (Area 58).
Placemen placida (Philippi, 1844), Portsea (Area 58).
Gomphina undulosa (Lamarck, 1818), Portsea–Point Lonsdale (Area 58).
Venerupis crevata (Lamarck, 1818), Portarlington (Area 29).
Venerupis exotica Lamarck, 1818.

Family PETRICOLIDAE.

Velargilla rubiginosa (Adams and Angas, 1863), Frankston (Area 48); off Portsea (Area 59).

Family DONACILLIDAE.

Donacilla erycinaea (Lamarck, 1818), Mentone (Area 24).

Family MACTRIDAE.

Nannomactra jacksonensis (Smith, 1885), off Point Cook (Area 5 and 11); Portsea (Area 59).

Family DONACIDAE.

Deltachion chapmani (Gatliff and Gabriel, 1923), Portsea (Area 59).

Family SANGUINOLARIIDAE.

Gari livida Lamarck, 1818, Hobsons Bay (Area 2 and 3); Frankston (Area 48).
Gari kenyoniana (Pritchard and Gatliff, 1904), off bank of Symonds' Channel (Area 52); Portsea (Area 59); Rye (Area 68).

Family SEMELIDAE.

Semelangulus tenuiliratus (Sowerby, 1867).

Family TELLINIDAE.

Homalina diemenensis (Deshayes, 1854), Corio Bay (Areas 25, 26, 37, 38).
Tellina albinella Lamarck, 1818, Point Nepean (Area 58); Sorrento (Area 59).

Family SOLENIDAE.

Solen vaginoides (Lamarck, 1818), Altona (Area 5); Portarlington (Area 29); Portsea (Area 59).

Family HIATELLIDAE.

Hiatella subalata (Gatliff and Gabriel, 1910), off Point Cook (Area 5 and 11); Frankston (Area 48); Dromana (Area 63); Portsea (Area 59).
Panopea australis Sowerby, 1833, off Portsea (Area 59).

Family TEREDINIDAE.

This family is represented by several species which cause damage to wooden shore structures and at the present time a detailed study is being made of prevalence of attack and the species involved in Victoria.

Family MYOCHAMIDAE.

Myadora pandoriformis (Stutchbury, 1830).

Family THRACIIDAE.

Eximiothracia speciosa (Angas, 1869), Frankston (Area 48).
Eximothracia lincolnensis (Verco, 1907), Frankston (Area 48); Dromana (Area 63).
Thraciopses elongata (Stutchbury, 1835).

Family CLAVAGELLIDAE.

Humphryeia strangei A. Adams, 1852.

PLATE I.

FIG. 1

FIG. 2.

FIG. 3.

FIG. 4.

Euprymna tasmanica Pfeffer.

FIG. 1. Dorsal view ×.

FIG. 2. Ventral view ×.

FIG. 3. Oral region showing enlarged suckers.

FIG. 4. Hectocotylized arm of ♂.

PLATE II.

FIG. 1.

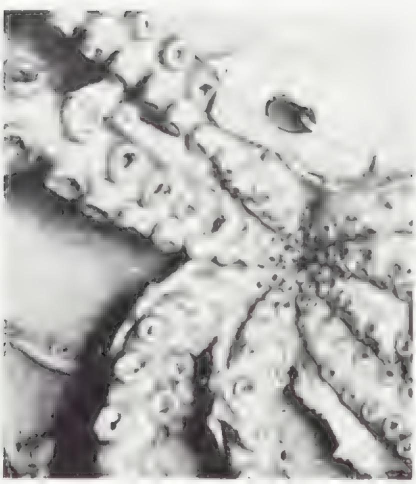

FIG. 2.

FIG. 3.

Octopus flindersi Cotton.

FIG. 1. General view of ♂ Nat. Mus. No. F 1516.

FIG. 2. Buccal region.

FIG. 3. Tip of hectocotylized arm showing Ligula.

PLATE III.

FIG. 1.

FIG. 2.

Octopus superciliosus Quoy & Gaimard.

FIG. 1. Living specimen from Port Phillip Bay.

FIG. 2. Oyster shell containing ♀ brooding eggs. Elongated eggs and tentacles of female can be distinguished.

PLATE IV

FIG. 1

FIG. 2

FIG. 3.

FIG. 4.

Octopus superciliosus Quoy & Gaimard.

FIG. 1. Dorsal view of Holotype Museum Nationale d'Histoire Naturelle Paris.

FIG. 2. Ventral view of Holotype.

FIG. 3. Ventral view of Paratype I.

FIG. 4. Oral surface of Paratype I

PLATE V.

FIG. 1

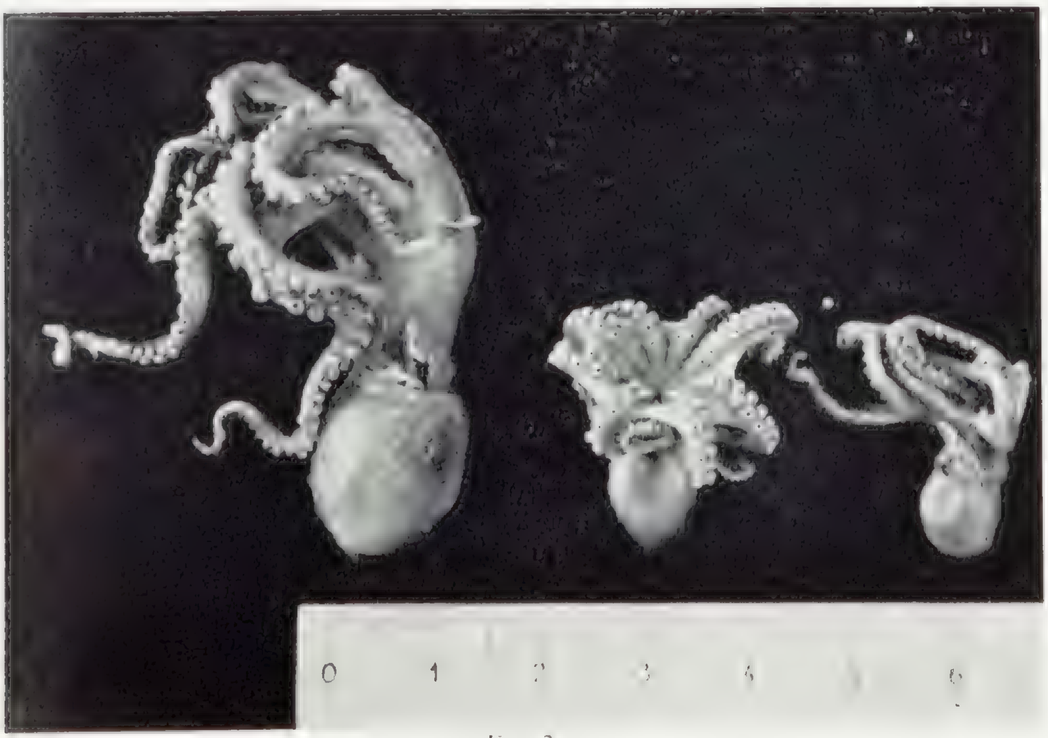

FIG. 2.

Octopus superciliosus Quoy & Gaimard.

FIG. 1. Dorsal view of Holotype (left) and Paratypes I. and II.

FIG. 2. Ventral view of Holotype (left) and Paratypes I. and II.

PORT PHILLIP SURVEY 1957–1963.

OPISTHOBRANCHIA.

By *ROBERT BURN*,

Honorary Associate in Conchology, National Museum of Victoria.

SUMMARY.

Eighty-eight species of Opisthobranchia are reported from Port Phillip Bay. The greatest concentration of species is in the Port Phillip Heads area south of the Nepean Bay Bar. North of the Bar, few suitable environments and dissipated currents severely restrict opisthobranch colonization.

INTRODUCTION.

Eighty-eight species of Opisthobranchia are reported here from the area covered by the Port Phillip Survey 1957–1963. Of these species, nineteen have been collected by the persons responsible for the Survey. However, in order to make this report as comprehensive as possible, two other sources of material have been utilized to their fullest extent.

The spirit collection of the National Museum of Victoria, Melbourne (NMV in text) contains specimens collected prior to the commencement of the Survey in 1957 and from sources other than the Survey during the years 1957–1963. This material includes nine species which were otherwise absent from this report and many locality records.

The writer's collection contains both the greatest number of species and specimens. Fifty-four species originated from this source, and most of these from Point Lonsdale where some of the best collecting grounds of the whole Victorian coastline are found. Many of the Point Lonsdale species, and a few from other localities, are new to science and have not yet been described. Wherever possible these new species have been listed under their correct genus, thus—16. *Elysia* sp. Where there is some doubt regarding the generic placement, the genus is listed with a question-mark in parenthesis, thus—21. *Hermaea* (?) sp.

The species are correspondingly numbered in both the text and Table 1 for the convenience of easy reference between the two.

Localities are recorded as Area and either place name or station number (if Port Phillip Survey material). Position of areas and stations are shown on Charts 1 and 2 (back of volume).

Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171 Port Phillip with the numbered Area grid superimposed. Chart 2 shows position of the stations numbered 1—317 with the same grid super-imposed to aid in location of the stations and for correlation with depth &c. Localities in the text are shown as area number followed immediately by the station number in brackets. Table A (back of volume) records station number, date, area, method of collecting (dive or dredge) and depth in fathoms.

The classification used is basically that of Odhner (1926, 1939) except in the order Sacoglossa where that of Boettger (1963) is used with some alterations by the writer.

5050/64.—**18**

SYSTEMATIC LIST OF SPECIES.

Subclass *OPISTHOBRANCHIA.*

Order **CEPHALASPIDEA.**

Suborder **Bullacea.**

Family Bullidae.

1. *Bulla botanica* Hedley.

Bulla botanica Hedley, 1918, *J. Roy. Soc. N.S.W.*, 51, Suppl.: M. 104.

Quibulla botanica. Iredale, 1929, *Aust. Zool.*, **5** : 349, pl. 38, fig. 4.

Bullaria botanica. Macpherson and Gabriel, 1962, *Mar. Moll. Vict.*; 242, fig. 281.

MATERIAL: Port Phillip Survey; Area 37 (40); 37 (296); 37 (297). N.M.V. coll. Rye (Area 68), 1 spec., intertidal.

REMARKS: This fairly common large species inhabits the quieter and deeper parts of the Bay where muddy sands predominate.

Suborder **Scaphandracea.**

Family Atyidae.

2. *Haminoea brevis* (Quoy and Gaimard).

Bulla brevis Quoy and Gaimard, 1832, *Voy. Astrolabe, Zool.*, **2** : 358,, pl 26. fig. 36–37.

Haminoea brevis. Macpherson and Gabriel, 1962, *Mar. Moll. Vict.*; 242, fig. 282.

MATERIAL: Port Phillip Survey; Area 55 (39); Burn coll. Rosebud, (Area 69), 100 + spec., intertidal. Off Dromana (Area 63), 2 spec., dredged 5 fathoms.

REMARKS: This species is localized to the sandy-mud flats and deeper parts of south-eastern Port Phillip Bay. It is very abundant intertidally. The animal is creamy-yellow with minute purple-brown specks in the shell mantle. A terminally orange yellow periostracum is present on nearly all Bay specimens.

3. *Haminoea tenera* (A. Adams).

Bulla tenera A. Adams, 1850, *Thes. Conch.*, **2** : 583, pl. 124, fig. 103.

Haminoea tenera Macpherson and Gabriel, 1962, *Mar. Moll. Vict.*; 243, fig. 283.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 3 spec., intertidal; Portarlington, (Area 29), 20 + spec., intertidal.

REMARKS: Unlike its congener *H. brevis*, this species browses on the minute epiphytic growths on brown algae and the strapweed, *Zostera*, and on the slimy green alga, *Chaetomorpha*. The animal is dull grey or darker with orange or pale spots; the shell is hyaline and without periostracum.

Suborder **Philinacea.**

Family Philinidae.

4. *Philine angasi* (Crosse and Fischer).

Bullaea angasi Crosse and Fischer, 1864, *J. Conchyliol.*, **13** : 38, pl. 2, fig. 8.

Philine angasi. Macpherson and Gabriel, 1962, *Mar. Moll. Vict.*; 246, fig. 286.

MATERIAL: Port Phillip Survey; Areas 5 (169); 7 (208); 9 (178–9); 11 (190); 12 (113); 13 (92); 18 (307–8); 19 (181); 23 (2); 27 (48); 31 (132); 38 (127); 39 (314); 42 (289); 61 (37); 64 (164); 6 (64; 65; 67); 26 (—); 42 ((38). N.M.V. coll.; Davy Bay

(Area 48), 3 spec., intertidal; Aspendale (Area 24). 5 spec., intertidal; Cheltenham Beach (Area 14), 2 spec., intertidal; St. Kilda (Area 7), 4 spec., intertidal; South Melbourne (Area 3), 10+ spec., intertidal; Port Melbourne (Area 2), 3 spec., intertidal; Newport (Area 2), 10+ spec., intertidal; Eastern Beach, Corio Bay (Area 37), 2 spec., intertidal; Corio Bay (Area 25), 10+ spec., dredged 3 fathoms; Seaholme (Area 5), 1 spec., intertidal; Mornington (Area 55), eggs, intertidal; Rosebud (Area 69), 4 spec., intertidal.

REMARKS: *P. angasi* is the most common species of the whole of Port Phillip Bay, occurring abundantly both intertidally and in deeper waters where sandy-mud predominates. It is of note that the species is found only in the Inner Basin, that is north of the Nepean Bay Bar. The fragile whitish shell is often found cast up upon Bay-side beaches. The animal is easily recognized by its creamy-white colour and oval shape.

Family DORIDIIDAE.

5. *Doridium queritor* (Burn).

Aglaia queritor Burn, 1957, *Vict. Nat.*, **74** : 117, fig. 1.

MATERIAL: Port Phillip Survey; Area 26 (—). Burn coll.; Portarlington (Area 29); 3 spec., intertidal; Portsea Ocean Beach (Area 59), 1 spec., intertidal; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: This species is not particular in its habitat; it has been found crawling through sand, under stones, on brown alga and crawling through short algal growths on rock platforms. *D. queritor* is easily recognized by its uniform velvet black colour and small size.

6. *Doridium taronga* (Allan).

Aglaia taronga Allan, 1933, *Rec. Aust. Mus.*, **18** : 444, pl. 56, fig. 1–3.
Aglaia taronga. Burn, 1957, *Vict. Nat.*, **74** : 117, fig. 2.

MATERIAL: Burn coll.; Swan Bay (Area 58), 1 spec., intertidal; Rosebud (Area 69), 1 spec., intertidal.

REMARKS: Found crawling through mud and sand. The body-colour is mottled brown with orange submarginal spots and a median pale stripe on the head. The species is very rare; besides the two specimens recorded above, the writer knows of only two others, respectively from New South Wales and southern Queensland.

7. *Doridium cyaneum* Martens.

Doridium cyaneum Martens, 1880, *Monatsb. K. Akad. Wiss. Berlin*, **1879** : 738.
Aglaia cyaneus. Allan, 1950, *Aust. Shells;* 217, fig. 3–5.

MATERIAL: Port Phillip Survey; Area 37 (296–297).

REMARKS: The only specimen was dredged in $1\frac{1}{4}$—2 fathoms on sandy-mud. The species has not previously been recorded from Victoria but is rather common in New South Wales and Queensland. Probably *Aglaia troubridgensis* Verco (1909, *Trans. Roy. Soc. S. Aust.*, 33 : 276, pl. 20, fig. 4–5) from South Australia is identical with this large species. The animal is velvety-black in colour, generally with spots, blotches, lines or stipples of yellow on the dorsal surface.

Suborder **Runcinacea.**

Family Runcinidae.

8. *Ilbia ilbi* Burn.

Ilbia ilbi Burn, 1963, *Aust. Zool.*, **13** : 15, fig. 12-20.

MATERIAL: Burn coll.; Point Lonsdale, Area 58 2 spec., intertidal.

REMARKS: Found crawling among the green alga *Enteromorpha* and on coralline algae; very rare. This species is less than 4 mm. long in life; it has a yellow patterned purple body and no gills.

Order **Anaspidea.**

Family Aplysiidae.

9. *Aplysia parvula* Mörch.

Aplysia parvula Morch, 1863, *J. Conchyliol.*, **11** : 22.

Aplysia norfolkensis Sowerby. Allan, 1950, *Aust. Shells*; 212, fig. 3.

Aplysia parvula. Macpherson and Gabriel, 1962, *Mar. Moll. Vict.*; 247, fig. 288.

MATERIAL: Port Phillip Survey; Area 50 (230); N.M.V. coll.; Sorrento Back Beach, Area 66, 3 spec., intertidal; Point Lonsdale (Area 58), 10 + spec., intertidal.

REMARKS: Rather uncommon in the Bay; usually found among heavy algal growths on reefs and rocks. *A. parvula* is easily recognized by the black margins of the parapodia, tentacles and rhinophores.

10. *Aplysia sydneyensis* Sowerby.

Aplysia sydneyensis Sowerby, 1869, *Conch. Icon.*, 17, Aplysia: pl. 7, fig. 31.

Aplysia sydneyensis. Eales, 1960, *Bull. Brit. Mus. (N.H.)*, Zool., **5** : 348, fig. 37.

Aplysia sydneyensis. Macpherson and Gabriel, 1962, *Mar. Moll. Vict.*; 247, fig. 289.

MATERIAL: N.M.V. coll.; Rosebud (Area 69), 2 spec., intertidal; Dromana (Area 63), 1 spec., intertidal; Melbourne (Area 2), 2 spec., intertidal; Burn coll.; Swan Bay (Area 58), 30 + spec., intertidal; Rosebud (Area 69), 2 spec., intertidal.

REMARKS: Common intertidally on *Zostera* beds during April–May–June when copulation and egg-laying take place. The living animals are up to eight inches in length and vary in colour from pale yellow to dark brown with darker veining and patches on the outer surfaces of the body. This species was identified with *A. hyalina* Sowerby 1869 in a previous paper (Burn, 1958, *J. Malac. Soc. Aust.*, 2 : 21, fig. 1).

Order **Sacoglossa.**

Suborder **Juliacea.**

Superfamily Julioidea.

Family Berthelinidae.

11. *Tamanovalva babai* Burn.

Tamanovalva babai Burn, 1965, *Nature*, vol. 206, No. 4985, 735–736, fig., *Berthelinia typica Burn*, 1960, non Gatliff and Gabriel, 1911.

MATERIAL: Burn coll.; Portarlington (Area 29), 20 + spec., intertidal.

REMARKS: Found on the green algae, *Caulerpa sedoides*, *scalpelliformis* and *simpliciuscula*. The living slugs are uniformly green, the shells ovate-trigonal. This species has been identified (Burn, 1960, *Nature*, 187: 44) with the next species but is both specifically and generically distinct.

12. *Edenttellina typica* Gatliff and Gabriel.

Edenttellina typica Gatliff and Gabriel, 1911, *Proc. Roy. Soc. Vict.*, pl. 46, fig. 5–6.

MATERIAL: N.M.V. coll.; Point Lonsdale (Area 58), 20 + spec., intertidal; Burn coll.; Point Lonsdale (Area 58), 30 + spec., intertidal; Portsea Ocean Beach (Area 59), 5 spec., intertidal.

REMARKS: Found on the green alga, *Caulerpa brownii.* The animal is pale green with black lines on the shell mantles; the shell is ovate.

Suborder **Oxynoacea.**

Superfamily OXYNOIDEA.

Family OXYNOIDAE.

13. *Oxynoe viridis* Pease.

Oxynoe viridis Pease, 1861, *Proc. Zool. Soc.*: 246.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal; Portsea Ocean Beach (Area 59), 2 spec., intertidal.

REMARKS: Found on a number of different species of the green alga, *Caulerpa.* The small opaque shell is bulla-form, the much larger long-tailed animal is green with yellow and blue spots. The tail is often cast off like that of a lizard when handled.

Family ELYSIIDAE.

14. *Elysia furvacauda* Burn.

Elysia furvacauda Burn, 1958, *J. Malac. Soc. Aust.*, **2** : 22, pl. 1, fig. 1.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling over brown alga and stones; very rare. The animal is a dull pinkish brown colour with small blue patches.

15. *Elysia australis* (Quoy and Gaimard).

Acteon australis Quoy and Gaimard, 1832, *Voy. Astrolabe, Zool.*, **2** : 317, pl. 24, fig. 18–20.

Elysia coodgeensis Angas, 1864, J. Conchyliol., **12** : 69, pl. 6, fig. 4.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found on the small green alga, *Enteromorpha.* The animal is pale green in colour with black tips to the head parts and tail. This is the first record of this species from Victoria; it is very common in New South Wales.

16. *Elysia* sp.

MATERIAL: N.M.V. coll.; Mordialloc (Area 24), 2 spec., dive 2 fathoms; Mornington Jetty (Area 55), 3 spec., dive 2 fathoms.

REMARKS: Found on a species of green alga; known only from Port Phillip Bay. The animal is yellowish green in colour with black tips to the rhinophores.

Superfamily Polybranchiodea.

Family Lobigeridae.

17. *Lobiger wilsoni* Tate.

Lobiger wilsoni Tate, 1889, *Trans. Roy. Soc. S. Aust.*, **11** : 66, pl. 11, fig. 12.

MATERIAL: Burn coll.; Portsea Ocean Beach (Area 59), 1 spec., intertidal.

REMARKS: Found on the green alga, *Caulerpa*. The yellowish shell is elongate bulla-form, the animal green, yellow and mauve with two smooth spatulate flaps on each side of the body.

Family Polybranchidae.

18. *Polybranchia pallens* (Burn).

Cyerce nigra pallens Burns, 1957, *J. Malac. Soc. Aust.*, **1** : 14, pl. 3, fig. 8–11.
Branchophyllum pallens, Burn, 1960, *Ibid.*, **4** : 70.

MATERIAL: Burn coll.; Queenscliff (Area 58), 7 spec., intertidal.

REMARKS: Found under stones and on the green alga, *Caulerpa brownii*. The species grows to 50 mm. in length and is pink and green on the body with brownish leaf-like cerata all round the body. Some uncertainty remains about the correct generic placement of this species.

19. *Polybranchia* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on brown alga. Much smaller than the above species, yellowish in colour and with pustulose cerata.

Family Hermaeidae.

20. *Hermaea* (*Placida*) sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on brown alga. This is an all green species with long cerata on each side of the body. The genus is a new record for Australia.

21. *Hermaea* (?) sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on brown alga. This is a distinctive species with white body and flat red cerata.

22. *Hermaea* (?) sp.

MATERIAL: N.M.V. coll.; Two Sisters, Sorrento (Area 67), 1 spec., intertidal.

REMARKS: Found crawling on brown alga. A 50 mm. long green species with gill lamellae on the ceratal stalks.

Superfamily Stiligeroidea.

Family Stiligeridae.

23. *Stiliger* sp.

MATERIAL: N.M.V. coll.; Rosebud Pier (Area 69), 2 spec., on *Zostera*; Burn coll.: Point Lonsdale (Area 58), 100 + spec., intertidal.

REMARKS: Point Lonsdale specimens feed on a small *Enteromorpha*-like green alga growing on the shore-platform; Rosebud specimens feed on epiphytic algal growths on the *Zostera*. This species is very common annually at Point Lonsdale during the months of July to September. In an area of 50 yards by 20 yards of the shore-platform, the density of specimens per square yard varied from twelve to 50, the minimum number of specimens thus being 12,000 (date of count, 13 August 1961). Yet prior to 1961, the species had not been observed in Victoria.

Order **Notaspidae.**

Suborder **Umbraculacea.**

Family TYLODINIDAE.

24. *Tylodina corticalis* (Tate).

Umbrella corticalis Tate, 1889, *Trans. Roy. Soc. Aust.*, **11** : 65, pl. 11, fig. 11.
Tylodina corticalis. Burn, 1960, *J. Malac. Soc. Aust.*, **4** : 64, fig. 1–9.

MATERIAL: N.M.V. coll.; Portsea Ocean Beach (Area 59), 1 spec., intertidal.

REMARKS: Found on alga at low tide level; the type locality is South Channel, Port Phillip Bay, 7–16 fathoms, on sand and weed. The living animal is bright yellow. The shell is fragile and covered in life by a thick ribbed periostracum.

Suborder **Pleurobranchacea.**

Family PLEUROBRANCHIDAE.

25. *Oscanius hilli* Hedley.

Oscanius hilli Hedley 1896, *Proc. Linn. Soc. N.S.W.*, **19** : 127, pl. 7.

MATERIAL: N.M.V. coll.; Portsea Pier (Area 59), 1 spec., shallow water.

REMARKS: In shallow water and dredged among *Zostera*. This is the first record of this large plum-coloured species from Port Phillip Bay. There is no shell in this species.

26. *Berthella mediatas* Burn.

Berthella mediatas Burn, 1962, *Mem. Nat. Mus. Melb.*, **25** : 142, pl. 2, fig. 7–8.

MATERIAL: Burn coll.; Portarlington (Area 29), 13 spec., intertidal; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Generally found in numbers under stones. The animal is palest yellow in colour and has an internal shell of nearly 12 mm. length.

Family PLEUROBRANCHAEIDAE.

27. *Pleurobranchaea maculata* (Quoy and Gaimard).

Pleurobranchidium maculatus Quoy and Gaimard, 1832, *Voy. Astrolabe*, Zool., **2** : 301, pl. 31, fig. 11–14.
Pleurobranchaea maculatus. Allan, 1950, *Aust. Shells*; 208, fig. 1.

MATERIAL: Port Phillip Survey; Areas 11 (—); 13 (92). N.M.V. coll.; Mordialloc (Area 24), 3 spec., intertidal; Portsea Pier (Area 59), 3 spec., shallow water; Sorrento Ocean Beach (Area 66), 1 spec., intertidal.

REMARKS: Inhabits sandy-rocky positions within a fast flow of water. The species is a voracious predator of smaller shell-less opisthobranchs.

Order **Nudibranchia.**

Suborder **Doridacea.**

Section Eudorididacea.

Tribe Cryptobranchia.

Family DORIDIDAE.

28. *Chromodoris alternata* (Burn).

Glossodoris alternata Burn, 1957, *J. Malac. Soc. Aust.*, **1** : 17, pl. 1, fig. 10–11.

MATERIAL: Burn coll.; Portarlington (Area 29), 10 spec., intertidal; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. The middle part of the back is red, the marginal area is alternately white and blue.

29. *Chromodoris haliclona* (Burn).

Glossodoris haliclona Burn, 1957, *Ibid.;* 17, pl. 3, fig. 2.

MATERIAL: N.M.V. coll.; Seaholme (Area 5), 10 spec., intertidal; Burn coll.; Portarlington (Area 29), 7 spec., intertidal.

REMARKS: Found living on and in association with the pink encrusting sponge, *Haliclona.* The animal is identical in colour with the sponge except for a marginal series of white patches.

30. *Chromodoris perplexa* (Burn).

Glossodoris perplexa Burn, 1957, *Ibid.;* 17, pl. 3, fig. 1.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. The slender body is white with a purple dorsal margin and orange spots on the sides and back.

31. *Chromodoris tasmaniensis* Bergh.

Chromodoris tasmaniensis Bergh, 1904, *Malac. Unters.*, 6 (2): 69, pl. 5, fig. 12–15.

Glossodoris tasmaniensis. Burn, 1957, *J. Malac. Soc. Aust.*, **1** : 17, pl. 2, fig. 10.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species has a creamy-white body with a double row of red spots on the dorsal margin and red spots on the sides and back. Large specimens attain 50 mm. in length.

32. *Chromodoris victoriae* (Burn).

Glossodoris victoriae Burn, 1957, *Ibid.;* 16, pl. 3, fig. 4.

MATERIAL: Burn coll.; Portarlington (Area 29), 2 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. The body is white with a single row of red spots around the back and pale blue lines on the middle-part of the back. Large specimens grow to 30 mm. in length.

33. *Chromodoris* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species is similar to *C. perplexa* (Burn) except that the dorsal margin has a double row of purple spots.

34. *Hypselodoris* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on weed. This species is pure white except for a yellow margin to the back and foot.

35. *Noumea* sp.

MATERIAL: N.M.V. coll.; Portsea Pier (Area 59), 3 spec., intertidal; Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found crawling on weed. The animal grows to 10 mm. in length and is pale pink in colour with red or orange spots on the back.

36. *Hallaxa indecora* (Bergh).

Halla indecora Bergh, 1905, *Siboga–Exped.*, **50** : 116, pl. 15, fig. 3–6.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. A velvety appearance, a sinuate anterior edge of the foot and pale yellow or orange colouration distinguish this species.

37. *Rostanga arbuta* (Angas).

Doris arbutus angas 1864, *J. Conchyliol.*, **12** : 47, pl. 4, fig. 4.

MATERIAL: Port Phillip Survey; Area 59 (213); Burn coll.; South Channel (near Hovell Light) (Area 60), 1 spec., dredged 8 fathoms.

REMARKS: Found under and crawling over stones; dredged. The animal is easily recognized by its bright red colour. In deeper water, the species associates with and lives on an orange sponge.

38. *Ceratosoma brevicaudatum* Abraham.

Ceratosoma brevicaudatum Abraham, 1876, *Ann. Mag. Nat. Hist.*, (4), **18** : 142, pl. 8, fig. 6.

Ceratosoma brevicaudatum. Allan, 1950, *Aust. Shells;* 222, pl. 28, fig. 14.

MATERIAL: Port Phillip Survey: Areas 5 (53); 26 (—); 27 (138); 40 (101); 42 (38); 55 (39); 61 (37). N.M.V. coll.; Davy Bay (Area 55), 1 spec., intertidal; Mordialloc Area 24), 2 spec., intertidal; Cheltenham (Area 14), 10 + spec., intertidal; Hobson's Bay (Area 2), 1 spec., intertidal; Burn coll.; Portarlington (Area 29), 12 spec., intertidal; Queenscliff (Area 58), 1 spec., intertidal; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found under stones and crawling about rock pools. It is one of the largest Victorian species, growing to 150 mm. in length. The body is high and slender, bright pink in colour with blue, green and red spots. The short tail of the back is purple-brown. This is the dominant nudibranch of the Victorian coastline (Burn, 1961, *Vict. Nat.*, 77 : 316).

39. *Austrodoris peculiaris* (Abraham).

Doris peculiaris Abraham, 1877, *Proc. Zool. Soc.*; 211, pl. 29, fig. 15–17.

MATERIAL: Port Phillip Survey: Areas 12 (196), 27 (48), 58 (88); N.M.V. coll.: Mornington (Area 55), 1 spec., intertidal; Rickett's Point (Area 23), 1 spec., intertidal; Point Lonsdale (Area 58), 1 spec., intertidal; Burn coll.; Queenscliff (Area 58), 6 spec., intertidal; Point Lonsdale (Area 58), 3 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This is a dull yellow species with numerous capstan-like papillae all over the back. Large specimens grow to 30 mm. in length and are very convex.

40. *Neodoris chrysoderma* (Angas).

Doris chrysoderma Angas, 1864, *J. Conchyliol.*, **12** : 46, pl. 4, fig. 3.
Praegliscita chrysoderma. Burn, 1957, *J. Malac. Soc. Aust.*, **1** : 19, pl. 1, fig. 1–5.

MATERIAL: Burn coll.; Queenscliff (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species is bright yellow with a number of large white pustules on the back. It grows to 40 mm. in length. The genus *Praegliscita* (Burn, 1957) is identical with the genus *Neodoris* (Baba, 1938) from Japan and South America.

41. *Alloiodoris nivosus* Burn.

Alloiodoris nivosus Burn, 1958, *Ibid.*, **2** : 29, pl. 2, fig. 14.
Alloiodoris marmorata. Basedow and Hedley, 1905, *Trans. Roy. Soc. S. Aust.*, **29** : 152, pl. 8, fig. 1–2.

MATERIAL: Port Phillip Survey; Areas 12 (196), 18 (61), 26 (—), 36 (—); Burn coll.; Portarlington (Area 29), 5 spec., intertidal.

REMARKS: Found under stones intertidally and in sponges in deeper water. The animal is either grey or white with dark grey and brown rosettes on the back. Brown spots pattern the underside.

42. *Doris pustulata* Abraham.

Doris pustulata Abraham, 1877, *Proc. Zool. Soc.*; 256, pl. 29, fig. 18–19.
Staurodoris pustulata. Allan, 1947, *Rec. Aust. Mus.*, **21** : 446, pl. 42, fig. 1–2.

MATERIAL: N.M.V. coll.; Portsea Pier (Area 59), 1 spec., shallow water.

REMARKS: Found under stones. This is an orange-yellow species with numerous large high pustules all over the back. It is a much flatter species than *Austrodoris peculiaris*.

43. *Trippa albata* Burn.

Trippa albata Burn, 1962, *Mem. nat. Mus. Melb.*, **25** : 101, fig. 5.

MATERIAL: Port Phillip Survey; Areas 10 (11); Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found both under stones and crawling on weed; dredged. This is a 10 mm. long pure white species with a furry back. Only five specimens are known, three from Port Phillip and two from Westernport.

44. *Thordisa sabulosa* Burn.

Thordisa sabulosa Burn, 1957, *J. Malac. Soc. Aust.*, **1** : 20, pl. 1, fig. 6–9.

MATERIAL: Burn coll.; Queenscliff (Area 58), 1 spec., intertidal.

REMARKS: Found under stones and crawling on weed. The animal is dark yellow with numerous spike-like papillae on the back; brown spots mark the underside. This is a rare species.

46. *Kentrodoris* (?) sp.

MATERIAL: N.M.V. coll.; Point Lonsdale (Area 58), 2 spec., intertidal; Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on weed in tide pool. This species is creamy-white with dark brown spots scattered over the back.

47. *Doris* (?) sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on weed in tide channel. This is a dusky-yellow flat species with faint reticulate patterning on the back.

Section Porostomata.

Family DENDRODORIDIDAE.

48. *Dendrodoris nigra* (Stimpson).

Doris nigra Stimpson, 1855, *Proc. Acad. Nat. Sci. Philad.*, **7** : 380.
Dendrodoris nigra. Allan, 1947, *Rec. Aust. Mus.*, **21** : 458.

MATERIAL: Port Phillip Survey; Area 42 (38); N.M.V. coll.; Altona (Area 5), 1 spec., intertidal; Burn coll.; Portarlington (Area 29), 2 spec., intertidal

REMARKS: Found under stones. This handsome velvet-black species often has a narrow carmine margin to the back and foot; it grows to 50 mm. in length.

49. *Dendrodoris vadisi* Burn.

Dendrodoris vadisi Burn, 1962 *Mem. nat. Mus. Melb.*, **25** : 166.

MATERIAL: Burn coll.; Portarlington (Area 29), 10 spec., intertidal.

REMARKS: Found under stones. This is a greenish-yellow species with low wart-like postules all over the back; it grows to 10 mm. in length.

50. *Doriopsilla aurea* (Quoy and Gaimard).

Doris aurea Quoy and Gaimard, 1832, *Voy. Astrolabe*, Zool., **2** : 265, pl. 19, fig. 4–7.

Doriopsis aurea. Basedow and Hedley, 1905, *Trans. Roy Soc. S. Aust.*; **29** : 157, pl. 7, fig. 4.

MATERIAL: Port Phillip Survey; Areas 30 (—), 59 (36); Burn coll.; Portarlington (Area 29), 4 spec., intertidal.

REMARKS: Found under stones. This species is wholly orange or shades thereof with white punctae on the back. It is somewhat larger (50 mm. long) and smoother than either of the next two species.

51. *Doriopsilla carneola* (Angas).

Doris carneola Angas, 1864, *J. Conchyliol.*, **12** : 48, pl. 4, fig. 7.
Doriopsis carneola. Basedow and Hedley, 1905, *Trans. Roy. Soc. S. Aust.*, **29** : 157, pl. 6, fig. 1–2.

MATERIAL: Port Phillip Survey; Areas 11 (—), 42 (38), 13 (—); N.M.V. coll.; Altona, (Area 5), 3 spec., intertidal; Drysdale (Area 40), 2 spec., intertidal; Mount Eliza (Area 47), 2 spec., intertidal. Burn coll.; Portarlington (Area 29), 3 spec., intertidal; Queenscliff (Area 58), 1 spec., intertidal.

REMARKS: Found under stones. The back of *D. carneola* is reddish brown often with white punctae and the sole of the foot is yellow or white. The back is finely granulate.

52. *Doriopsilla staminea* (Basedow and Hedley).

Archidoris staminea Basedow and Hedley, 1905, *Ibid.*, **29** : 151, pl. 6, fig. 3–4.

MATERIAL: Port Phillip Survey; Areas 56 (295), 37 (296–7), 36 (—); N.M.V. coll.; Seaholme (Area 5), 1 spec., intertidal; Burn coll.; Portarlington (Area 29), 5 spec., intertidal.

REMARKS: Found under stones and dredged. This species is wholly yellow or white with numerous large granulations on the back.

Tribe Phanerobranchia.

Superfamily NONSUCTORIA.

Family POLYCERIDAE.

53. *Crimora multidigitalis* (Burn).

Euphurus multidigitalis Burn, 1957, *J. Malac Soc. Aust.*, **1** : 15, pl. 2, fig. 1–6.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 6 spec., intertidal.

REMARKS: Found under stones and crawling on weed. This little yellow species has a fringe of very short branching black papillae around the back. An examination of the radula indicates that this species should be placed in *Crimora* (Alder and Hancock, 1862). The teeth are shaped as usual in this genus, the formula being 38 x 10—8.6—7.2.0 .2.6—7.10—8.

54. *Polycera parvula* (Burn).

Palio parvula Burn, 1958, *Ibid.*, **2** : 23, pl. 1, fig. 2–3.

MATERIAL: N.M.V. coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species is blood-red in colour and not more than 10 mm. long.

55. *Polycera janjukia* Burn.

Polycera janjukia Burn, 1962, *Mem. Nat. Mus. Melb.*, **25** : 99, fig. 31–4.

MATERIAL: N.M.V. coll.; Point Lonsdale (Area 58), 1 spec., intertidal; Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found under stones and crawling on weed. This species is smaller than the last, bright pink in colour with yellow spots on the sides and back.

56. *Tambja verconis* (Basedow and Hedley).

Nembrotha (?) *verconis* Basedow and Hedley, 1905, *Trans. Roy. Soc. S. Aust.*, **29** : 158, pl. 2, fig. 1–2.

MATERIAL: Port Phillip Survey; Area 61 (37).

REMARKS: Taken by skin-divers in 2 fathoms (above specimen) and dredged to 20 fathoms. *T. verconis* is a large 60–70 mm. long primrose coloured species with blue edgings to the foot and head.

Superfamily SUCTORIA.

Family GONIODORIDIDAE.

57. *Okenia* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on brown alga. A very small species, at most 4·5 mm. in length, with elongate papillae on the edges and in the middle of the back; colour pale brown.

58. *Eucrairia mapae* (Burn).

Drepaniella mapae Burn, 1961, *Veliger*, **3** : 102, fig. 1–2.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found crawling on weed. *E. mapae* is a little brown and white species with a pair of bifid horns on the head and a pair of elongate papilla beside the gills.

59. *Goniodoris meraculus* Burn.

Goniodoris meraculus Burn, 1958, *J. Malac. Soc. Aust.*, **2** : 27, pl. 2, fig. 10–11.

MATERIAL: N.M.V. coll.; Portsea Pier (Area 59), 1 spec., shallow water.

REMARKS: Found both under stones and crawling on weed. This pale fawn species has a narrow upstanding rim all around the back.

Suborder **Arminacea.**

Section Metarminacea.

Tribe Pachygnatha.

Family MADRELLIDAE.

60. *Madrella sanguinea* (Angas).

Janus sanguineus Angas, 1864, *J. Conchyliol.*, **12** : 63, pl. 6, fig. 5.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal; Portarlington (Area 29), 2 spec., intertidal.

REMARKS: Found crawling on rocks and weed in tide pools; *M. sanguinea* lives on a bright red Bryozoan that is common beneath stones in the lower intertidal zone. When picked up or irritated, specimens discharge a red staining fluid from the fringe of cerata around the back.

Family ANTIOPELLIDAE.

61. *Antiopella* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This new species has smooth cerata pigmented with various hues of blue, orange and yellow.

62. *Janolus* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species is rather like *Antiopella* sp. in shape but the cerata are rugose and the body brown.

63. *Proctonotus affinis* Burn.

Proctonotus affinis Burn, 1958, *J. Malac. Soc. Aust.*, **2** : 32, pl. 2, fig. 15.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 3 spec., intertidal.

REMARKS: Found both under stones and crawling on weed; fairly common. Like the preceding two species in shape but pale brown, orange and yellow in colour.

Suborder **Dendronotacea.**

Family Tritoniidae.

64. *Paratritonia lutea* Baba.

Paratritonia lutea Baba, 1949, *Opisthobranchia of Sagami Bay*: 166, pl. 34, fig. 123.

MATERIAL: Port Phillip Survey; Area 61 (37).

REMARKS: Skin-divers collected the only specimen taken, living on the gorgonian coral, *Mopsella*, in 2 fathoms. The species is pink and has branched gills along each side of the body. *P. lutea* was originally described from Japan.

65. *Tritonia* (?) sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 5 spec., intertidal.

REMARKS: Found crawling on weed in a tide pool. Similar in shape to the above species but smaller and mauve with silver patterning.

66. *Tritonia* (?) sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 4 spec., intertidal.

REMARKS: Found crawling on weed in a tide pool. This is larger than the above species and bright red and yellow in colour.

Family Tethyidae.

67. *Melibe australis* (Angas).

Melibaea australis Angas 1864. *J. Conchyliol.*, **12** : 62, pl. 6, fig. 2.
Melibe australis. Allan, 1947, *Rec. Aust. Mus.*, **47** : 459, pl. 43, fig. 8–9.
Melibe australis. Burn, 1957, *J. Malac. Soc. Aust.*, **1** : 23, pl. 1, fig. 12.

MATERIAL: Burn coll.; Queenscliff (Area 58), 10 spec., intertidal; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. *M. australis* is a creamy-white species with a bell-like mouth and four pairs of bulbous cerata along the back.

68. *Melibe maugeana* Burn.

Melibe maugeana Burn, 1960, *J. Malac. Soc. Aust.*, **4** : 70.
Melibe pellucida Burn, 1957, *Ibid.*, **1** : 24, pl. 3, fig. 5–7, (non Bergh 1902).

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. Similar to the above species in shape but with six pairs of fusiform cerata along the back. This species swims with a peculiar head-to-tail sideways movement.

Family DOTONIDAE.

69. *Doto ostenta* Burn.

Doto ostenta Burn, 1958, *J. Malac. Soc. Aust.*, **2** : 33, pl. 1, fig. 5.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found under stones and crawling on weed. Somewhat like the preceding two species but without the bell-like mouth. There are seven pairs of pink to grey to brown cerata along the back.

70. *Doto* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on weed in tide pool. Similar in shape to the above species but smaller and with only four pairs of fawn cerata along the back.

Suborder **Eolidacea.**

Tribe Pleuroprocta.

Family CORYPHELLIDAE.

71. *Coryphella* sp.

MATERIAL: Port Phillip Survey; Area 31 (—); Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Respectively the two specimens were collected by skin divers and found crawling on weed in a tide pool. This new species has a pale mauve body and small orange cerata.

72. *Coryphellina peonicia* (Burn).

Hervia poenicia Burn, 1957, *J. Malac. Soc. Aust.*, **1** : 25, pl. 2, fig. 7–10.
Coryphellina poenicia. Burn, 1962, *Mem. Nat. Mus. Melb.*, **25** : 107, fig. 9–10.

MATERIAL: Burn coll.; Portarlington (Area 29), 18 spec., intertidal; Point Lonsdale, (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species has a slender white body and elongate red cerata.

Tribe Acleioprocta.

Family EUBRANCHIDAE.

73. *Eubranchus rubeolus* Burn.

Eubranchus rubeolus Burn, 1964, *J. Malac. Soc. Aust.*, **8** : 13, fig. 6–10.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec. intertidal.

REMARKS: Found crawling on weed in tide pool. *E. rubeolus* is a small species with large blood-red patches along the sides and back and blood-red cerata.

74. *Capellinia* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec. intertidal.

REMARKS: Found crawling on weed in tide pool. This is a very small species which grows to no more than 5 mm. in length. It is brown in colour with knobbed cerata.

Family CUTHONIDAE.

75. *Trinchesia viridiana* (Burn).

Catriona viridiana Burn, 1962, *Mem. nat. Mus. Melb.*, **25** : 111, fig. 13.
Trinchesia viridiana. Burn, 1963, *J. Malac. Soc. Aust.*, **7** : 17, fig. 7–10.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec. intertidal.

REMARKS: Found both under stones and crawling on weed. This little species has a greenish yellow and dark green cerata.

76. *Trinchesia catachroma* (Burn).

Catriona catachroma Burn, 1963, *Ibid.*, **7** : 15, fig. 1–6.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 3 spec., intertidal

REMARKS: Found crawling on weed in tide pools. *T. catachroma* is a small slender pinkish cream species with yellow-banded grey cerata.

77. *Trinchesia sororum* Burn.

Trinchesia sororum Burn, 1964, *Ibid.*, **8** : 17, fig. 11–15.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec. intertidal.

REMARKS: Found crawling on weed in a tide pool. This is a small white species with purple bands on the tentacles and rhinophores, and maroon cerata.

78. *Toorna thelmae* Burn.

Toorna thelmae Burn, 1964, *Ibid.*, **8** : 19, fig. 16–21.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec. intertidal.

REMARKS: Found crawling on weed in a tide pool. This species has a pale pink and white body with yellow-banded orange cerata.

79. *Tergipes pauculas* Burn.

Tergipes pauculas Burn, 1962, *Mem. nat. Mus. Melb.*, **25** : 113, fig. 14.

MATERIAL: Burn coll.; Portarlington (Area 29), 1 spec., intertidal.

REMARKS: Found on weed under a stone; a unique specimen. *T. pauculas* is a pale orange 5 mm. long species with only three cerata along each side of the back.

Tribe Cleioprocta.

Family FACELINIDAE.

80. *Facelina newcombi* (Angas).

Flabellina newcombi Angas, 1864, *J. Conchyliol.*, **12** : 68, pl. 6, fig. 8.
Facelina newcombi. Burn, 1962, *Mem. nat. Mus. Melb.*, **25** : 114, figs. 15–16.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal; Portarlington (Area 29), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species has an elongate orange-yellow body with numerous brown cerata along the sides.

81. *Facelina hartleyi* Burn.

Facelina hartleyi Burn, 1962, *Ibid.*, **25** : 116, fig. 17.

MATERIAL Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. Similar in shape to the preceding species but much smaller, with a white body and red cerata.

82. *Facelina* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 2 spec., intertidal.

REMARKS: Found crawling on weed in a tide pool. This species has a bright pink body and yellow and white banded pink cerata.

83. *Palisa* sp.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on weed in a tide pool. This new species is uniformly opaque white except for a silver tracery on the body and cerata.

Family FAVORINIDAE.

84. *Cratena serrata* (Baba).

Hervia serrata Baba, 1949, *Opisthobranchia of Sagami Bay;* 179, pl. 46, fig. 156–157.
Cratena serrata. Burn, 1962, *Mem. nat. Mus. Melb.*, **25** : 119.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 5 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. *C. serrata* has a white body and slender flesh-pink cerata. The species was originally described from Japan.

85. *Austraeolis ornata* (Angas).

Flabellina ornata Angas, 1864, *J. Conchyliol.*, **12** : 67, pl. 6, fig. 7.
Flabellina ornata Allan, 1950, *Aust. Shells;* 224, pl. 28, fig. 1
Flabellina ornata Dakin, Bennett and Pope, 1952, *Aust. Seashores*; 270, pl. 62.
Austraeolis ornata Burn, 1962, *Mem. nat. Mus. Melb.*, **25** : 121, fig. 21–22.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed; this is the commonest Eolid species of eastern Australia. *A. ornata* is a large species of up to 35 mm. length with an orange and blue body and dark brown cerata variously spotted with blue, yellow, green, red, orange and brown.

86. *Austraeolis fucia* Burn.

Austraeolis fucia Burn, 1962, *Mem. Nat. Mus. Melb.*, **25** : 122, fig. 23–24.

MATERIAL: Burn coll.; Queenscliff (Area 58), 1 spec., intertidal.

REMARKS: Found crawling on weed in tide channel; unique. Like the above species in shape but with a white body and red cerata.

87. *Echinopsole breviceratae* Burn.

Echinopsole breviceratae Burn, 1962, *Ibid.*, **25** : 124, fig. 25–26.

MATERIAL: Burn coll.; Point Lonsdale (Area 58), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This species has a bright pink body with three rows of red spots along each side and short yellowish cerata.

Family Aeolidiidae.

88. *Aeolidiella macleayi* (Angas).

Eolis macleayi Angas, 1864, *J. Conchyliol.*, **12** : 65, pl. 6, fig. 4.
Aeolidiella macleayi. Burn, 1962, *Mem. Nat. Mus. Melb.*, **25** : 127.

MATERIAL: N.M.V. coll.; Mount Eliza (Area 47), 1 spec., intertidal.

REMARKS: Found both under stones and crawling on weed. This is a dull green and orange species with yellow maculated cerata.

DISTRIBUTION.

Eighty-eight species of Opisthobranchia occur within the confined area of Port Phillip Bay. The species can be divided into three groups according to their habitat; (i) five species (5·7 per cent.) are confined to sand and mud areas where they burrow through the soft substratum; *Bulla botanica, Haminoea brevis, Philine angasi, Doridium taronga* and *D. cyaneum*; (ii) three species (3·4 per cent.) live on or among *Zostera* beds: *Haminoea tenera, Aplysia sydneyensis* and *Oscanius hilli*; and (iii) 80 species (90·9 per cent.) depend upon a rock substratum either upon which to live and breed or to find the algal and epiphytic growths on which to feed.

The first group lives in the Inner Basin (Keble, 1946: 72, fig. 2, 6), a large area with a sand and mud bottom and weak sea currents. This expanse of the same habitat at once explains the occurrence of the species in both shallow and deeper waters.

The alga *Zostera* prefers a somewhat sandy position if it is to thrive, therefore its occurrence is rather limited in Port Phillip Bay. Consequently the species of the second group have restricted habitats and with the exception of *Aplysia sydneyensis* are rarely found alive.

The third and by far the largest group of species contains three assemblages, defined both by their known distribution and the physiography of Port Phillip Bay. Assemblage (i) is a large group of 58 species confined to the coastlines of Point Nepean to Sorrento and Point Lonsdale to

Queenscliff, and the intermediate insular South Channel Fort. This coastline is compatible with that part of the Bay south of the Nepean Bay Bar (Keble, loc. cit.). Rocky localities abound where species can colonize and survive.

Assemblage (ii) is governed by a sharp decrease in suitable rocky environments to the north and west of the Nepean Bay Bar. Where they do occur, quite strong colonies of species exist. Thus from the localities of Mount Martha to Frankston and Indented Head and Portarlington, 24 species are listed. Two of these, *Elysia* sp. from Mornington and Mordialloc and *Tergipes pauculas* from Portarlington are at present unique to Port Phillip Bay.

Assemblage (iii) is confined to the isolated rocky environments of the inner reaches of the Bay such as occur at Ricketts Point, Altona and Limeburners Point. Seven species are listed from these localities but all occur elsewhere in the Bay also.

It is presumed that the strong tidal currents entering Port Phillip through the Heads disperse widely and lose speed as they precipitate over the Nepean Bay Bar. Consequently, unless the free-swimming larvae or veliger stages of the opisthobranch species transported by these currents find a suitable rocky substratum upon which to settle, their chances of survival are negligible upon the muddy bottom of the Inner Basin. It would also seem that the species living in the inner reaches of the Inner Basin have either a better chance of survival by means of a longer veliger stage or have established themselves in colonies over successive generations by a progressive south to north movement.

Zoogeographically, the species of Port Phillip are compatible with the large cool-temperate eurythermal subfauna of south-eastern Australia (Burn, 1965: in press). An admixture of species of the small cool-temperate stenothermal subfauna of western Victoria and eastern South Australia also prevails but to what extent cannot yet be assessed.

ACKNOWLEDGMENTS.

The writer gratefully acknowledges the assistance of all persons concerned in the gathering of the material listed above. He is especially indebted to Miss J. Hope Macpherson, Curator of Molluscs, National Museum of Victoria, who so graciously passed on the Survey material and at whose suggestion this report was compiled.

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TABLE 1.—LOCALITIES OF OPISTHOBRANCH SPECIES IN PORT PHILLIP BAY.

S = Material collected during Port Phillip Survey. M = Material in National Museum of Victoria. B = Material in collection of the writer.

Species.	Localities																														
	Barwon Heads (Area 56).	Sorrento and Portsea Ocean Beaches (Area 66)	Portsea Pier (Area 59).	Two Sisters, Sorrento (Area 67).	Point Lonsdale (Area 58).	Queenscliffe (Area 58).	South Channel Fort (Area 61).	Swan Bay (Areas 50, 58).	Rye (Area 68).	Rosebud (Area 69).	Dromana (Area 63).	Martha Cliff (Area 63 64)	Mornington (Area 55).	Mt. Eliza (Area 47)	Davy Bay (Area 48).	Indented Head (Area 42).	Portarlington (Area 29).	St. George Light (Area 31).	Aspendale (Area 24, 36).	Mordialloc (Area 24)	Ricketts Point (Area 23).	Cheltenham Black Rock (Area 14).	St. Kilda (Area 7).	South Melbourne (Area 3).	Port Melbourne Newport (Area 2)	Altona Seaholme (Area 5).	Off Altona (Area 5).	Point Cook (Areas 4 5, 10 11).	Off Werribee (Areas 9, 18 19).	Corio Bay (Areas 25 28, 37 40).	Eastern Beach (Area 37).
1. *Bulla botanica*									M																					S	
2. *Haminoea brevis* ..										B	B		S																		
3. ,, *tenera* ..					B												B														
4. *Philine angasi*									S	M		S	M		M	S		S	M		S	M/S	M/S	M	M	M/S		S	S	M/S	M
5. *Doridium queritor* ..		B			B												B													S	
6. ,, *taronga* .								B		B																					
7. ,, *cyaneum* .																															S
8. *Ilbia ilbi* ..					B																										
9. *Aplysia parvula* ..		M			M			S																							
10. ,, *sydneyensis* ..								B		B/M	M														M						
11. *Tamanovalva babai* ..																	B														
12. *Edenttellina typica* ..		B			M/B																										
13. *Oxynoe viridis* .. .		B			B																										

14. *Elysia furvacauda* . .				B								
15. ,, *australis* . .				B								
16. ,, sp. . . .							M		M			
17. *Lobiger wilsoni* . .	B											
18. *Polybranchia pallens* . .					B							
19. ,, sp. . .				B								
20. *Hermaea* (*Placida*) sp. . .				B								
21. ,, (?) sp. . .				B								
22. ,, (?) sp. . .			M									
23. *Stiliger* sp.				B		M						
24. *Tylodina corticalis* . .	M											
25. *Oscanius hilli*		M										
26. *Berthella mediatas* . .			B					B				
27. *Pleurobranchaea maculata*	M	M							M	S		S
28. *Chromodoris alternata* . .				B				B				
29. ,, *haliclona* . .								B			M	
30. ,, *perplexa* . .				B								
31. ,, *tasmaniensis*				B								
32. ,, *victoriae* . .								B				
33. ,, sp. . .				B								
34. *Hypselodoris* sp. . .				B								
35. *Noumea* sp.		B		B								
36. *Hallaxa indecora* . .				B								

TABLE 1.—LOCALITIES OF OPISTHOBRANCH SPECIES IN PORT PHILLIP BAY—*continued.*

Species.	Localities.																														
	Barwon Heads (Area 56).	Sorrento and Portsea Ocean Beaches (Area 66).	Portsea Pier (Area 59).	Two Sisters, Sorrento (Area 67).	Point Lonsdale (Area 58).	Queenscliffe (Area 58).	South Channel Fort (Area 61).	Swan Bay (Areas 50, 58).	Rye (Area 68).	Rosebud (Area 69).	Dromana (Area 63).	Martha Cliff (Area 63 64).	Mornington (Area 55).	Mt. Eliza (Area 47).	Davy Bay (Area 48).	Indented Head (Area 42).	Portarlington (Area 29).	St. George Light (Area 31).	Aspendale (Area 24, 36).	Mordialloc (Area 24).	Ricketts Point (Area 23).	Cheltenham Black Rock (Area 14).	St. Kilda (Area 7).	South Melbourne (Area 3).	Port Melbourne Newport (Area 2).	Altona Seaholme (Area 5).	Off Altona (Area 5).	Point Cook (Areas 4 5, 10 11).	Off Werribee (Areas 9, 18 19).	Corio Bay (Areas 25 28, 37 40).	Eastern Beach (Area 37).
37. *Rostanga arbuta* . .			S				B																								
38. *Ceratosoma brevicaudatum*					B	B	S						S		M	S	B			M		M			M			S	S		S
39. *Austrodoris peculiaris* . .					B/M	S/B							M								M								S	S	
40. *Neodoris chrysoderma* . .						B																									
41. *Alloiodoris nivosus* . .																	B		S										S	S	
42. *Doris pustulata* . .			M																												
43. *Trippa albata*					B																							S			
44. *Thordisa sabulosa* . .						B																									
45. *Aphelodoris berghi* .			M																												
46. *Kentrodoris* (?) sp. .					M B																										
47. *Doris* (?) sp.		. .			B																										
48. *Dendrodoris nigra* . .																S	B									M					
49. ,, *vadisi* . .																	B														
50. *Doriopsilla aurea* . .			S														B	S													

51. ,, *carneola* ..				B		M	S	B			S	M	S	M	
52. ,, *staminea* ..	S							B		S		M			S
53. *Crimora multidigitalis* ..			B												
54. *Polycera parvula* ..			M												
55. ,, *janjukia* ..			M/B												
56. *Tambja verconis* ..					S										
57. *Okenia* sp.			B												
58. *Eucrairia mapae* ..			B												
59. *Goniodoris meraculus* ..		M													
60. *Madrella sanguinea* ..			B					B							
61. *Antiopella* sp.			B												
62. *Janolus* sp.			B												
63. *Proctonotus affinis* ..			B												
64. *Paratritonia lutea* ..					S										
65. *Tritonia* (?) sp. ..			B												
66. ,, (?) sp. .			B												
67. *Melibe australis* ..			B	B											
68. ,, *maugeana* ..			B												
69. *Doto ostenta*			B												
70. ,, sp.			B												
71. *Coryphella* sp. .. .			B						S						
72. *Coryphellina poenicia* ..			B					B							
73. *Eubranchus rubeolus* ..			B												

TABLE 1.—LOCALITIES OF OPISTHOBRANCH SPECIES IN PORT PHILLIP BAY—*continued.*

Species.	Barwon Heads (Area 56).	Sorrento and Portsea Ocean Beaches (Area 66).	Portsea Pier (Area 59).	Two Sisters, Sorrento (Area 67).	Point Lonsdale (Area 58).	Queenscliffe (Area 58).	South Channel Fort (Area 61).	Swan Bay (Areas 50, 58).	Rye (Area 68).	Rosebud (Area 69).	Dromana (Area 63).	Martha Cliff (Area 63 64).	Mornington (Area 55).	Mt. Eliza (Area 47).	Davy Bay (Area 48).	Indented Head (Area 42).	Portarlington (Area 29).	St. George Light (Area 31).	Aspendale (Area 24, 36).	Mordialloc (Area 24).	Ricketts Point (Area 23).	Cheltenham Black Rock (Area 14).	St. Kilda (Area 7).	South Melbourne (Area 3).	Port Melbourne Newport (Area 2).	Altona-Seaholme (Area 5).	Off Altona (Area 5).	Point Cook (Areas 4 5, 10-11).	Off Werribee (Areas 9, 18 19).	Corio Bay (Areas 25 28, 37 40).	Eastern Beach (Area 37).
74. *Capellinia* sp					B																										
75. *Trinchesia viridiana* ..					B																										
76. ,, *catachroma* ..					B																										
77. ,, *sororum* .					B																										
78. *Toorna thelmae* .					B																										
79. *Tergipes pauculas* ..																	B														
80. *Facelina newcombi* .					B												B														
81. ,, *hartleyi*					B																										
82. ,, sp. . .					B																										
83. *Palisa* sp.					B																										
84. *Cratena serrata* .					B																										
85. *Austraeolis ornata* ..					B																										
86. ,, *fucia* ..						B																									
87. *Echinopsole breviceratae* ..					B																										
88. *Aeolidiella macleayi* ..														M																	

PORT PHILLIP SURVEY 1957–1963.

ECHINODERMATA

By *AILSA M. CLARK.*

British Museum (Nat. Hist.).

SUMMARY.

The present paper deals mainly with the echinoderms collected by the Port Phillip Survey but also includes a study of some of the specimens collected in the vicinity of Port Phillip by J. B. Wilson toward the end of the last century and deposited in the British Museum. In addition there are details of further interesting material from localities outside the bay, notably from Cape Schank, which was sent to me together with the Survey specimens. The report starts with a fauna list in which the species taken by the Survey or by Wilson in Port Phillip appear in the left-hand column, while the other species that have been (or are now) recorded from that part of the Flindersian region east of the Great Australian Bight from depths of less than 40 fathoms (about 70 metres) appear on the right. This illustrates the limited number of species that occur within the bay. There follows the list of records of the Survey material, then details of certain of the species (including a few from outside Port Phillip) with keys to all the species given in both sides of the fauna list, each class being treated separately. Four new species, a starfish and three brittle-stars, are described, while remarks on an undetermined Antedonid and a Cucumarian of the genus *Stereoderma*, not previously represented in the waters of southern Australia, are included.

INTRODUCTION.

The echinoderm fauna of the eastern half of the Flindersian region from the Great Australian Bight to Wilson's Promontory, Victoria, is fairly well known from the works of H. L. Clark supplemented by Cotton and Godfrey's paper of 1942. However, few records exist of a number of the species and the localities of most of the specimens in the South Australian Museum reported on by H. L. Clark in 1928 (including the types of a number of species not otherwise known) are uncertain.

The fauna list given in this paper may need to be supplemented by the addition of further species at present only known from the other half of the Flindersian region, that is from south-west and western Australia. The possibility of this is emphasized by the discovery of *Nectria macrobrachia* among the additional material that had been collected at Cape Schank, Victoria sent to me by Miss Macpherson. This species was previously recorded only from Houtman's Abrolhos, off Geraldton, Western Australia.

The depth limit of 40 fathoms (73 metres) used in compiling the fauna list was chosen to allow a wide margin beyond the maximum depth of 10 or 11 fathoms in which collecting has been carried out in Port Phillip, and the depths at which skin-diving and small boat dredging are practicable.

The species in the left-hand column of the fauna list marked with an asterisk were not collected by the recent Survey but only by F. Bracebridge Wilson in the 1880s. Much of his material was the subject of a report by

Bell (1888), but since some of the specific names used by Bell were incorrect or have been referred to other genera I think it is worth while to include here an amended list. Wilson collected mainly just inside the Heads in the equivalent of areas 49, 50, 51, 58, 59 and 60; unfortunately few details of the precise localities remain with the specimens.

Positions of Areas and stations are shown on Charts 1 and 2 (back of volume).

Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171 Port Phillip with the numbered area grid superimposed.

Chart 2 shows position of the stations numbered 1—317 with the same grid superimposed to aid in location of the stations and for correlation with depth, &c.

Localities in the text are shown as Area number followed immediately by the station number in brackets. Table A (back of volume) records station number, date, method of collecting (dive or dredge) and depth in fathoms.

The greater part of this report was completed in December, 1962, but further interesting material collected in 1963, prompted some additions and a few alterations.

The Survey material together with some additional specimens from localities outside Port Phillip were sent to me by Miss J. Hope Macpherson, to whom I am indebted for the opportunity of carrying out this work.

Holotypes of new species described in this paper are deposited in the National Museum of Victoria.

FAUNA LIST OF ECHINODERMATA FROM DEPTHS OF LESS THAN 40 FATHOMS. (73 METRES.)

PORT PHILLIP (SURVEY & WILSON*)	OTHER EAST FLINDERSIAN SPECIES.
Crinoids:—	
Comanthus (Cenolia) trichoptera (J. Müller)	*C. (Cenolia) tasmaniae* A. H. Clark
**Ptilometra macronema* (J. M.)	[1]*Comatulella brachiolata* (Lamarck)
Aporometral wilsoni (Bell)	
Euantedon paucicirra H. L. Clark	
Antedon incommoda Bell	
Antedon loveni Bell	
Antedonid sp.	
Asteroids:—	
	Luidia australiae Döderlein
	Astropecten pectinatus Sladen
	[2]*Astropecten schayeri* Död.
	Astropecten vappa Müller & Troschel
[3]*Tosia australis* Gray	*Astropecten preissi* M. & Tr.

1. A. H. Clark (1931) mentions a specimen of *C. brachiolata* from Port Phillip in the British Museum collection; this cannot now be found.

2. *Astropecten schayeri* will probably prove to be a synonym of *A. pectinatus*

3. Livingstone's record of *Tosia tubercularis* (a synonym of *T. nobilis*) from this area I believe was based on a misidentification of *Tosia australis* forma *astrologorum*; see A.M.C., 1953

Asteroids—*continued.*

Tosia magnifica (M. & Tr.)
(synonyms *aurata* and *grandis*)
Pentagonaster duebeni Gray
(synonyms *crassimanus* and *stibarus*)
Nectria multispina H. L. C.

**Austrofromia polypora* (H.L.C.)
Petricia vernicina (Lmk.)
Patiriella gunni (Gray)
Patiriella calcar (Lmk.)
Paranepanthia grandis (H.L.C.)
Nepanthia hadracantha sp. nov.
Plectaster decanus (M. & Tr.)

Coscinasterias calamaria (Gray)
Allostichaster polyplax (M. & Tr.)

Uniophora granifera (Lmk.)

Nectria ocellata Perrier
Nectria macrobrachia H. L. C.
Anthaster valvulatus (M. & Tr.)

Patiriella exigua (Lmk.)
Asterina atyphoida H. L. C.

Echinaster arcystatus H.L.C.
Echinaster glomeratus H.L.C.
Australiaster dubius (H.L.C.)
Allostichaster regularis H.L.C.
[1]*Smilasterias irregularis* H.L.C.
Uniophora obesa H.L.C.
Uniophora multispina H.L.C.
Uniophora uniserialis H.L.C.
Uniophora gymnonota H.L.C.
Uniophora nuda (Per.)

Ophiuroids:—

Astroconus australis (Verrill)

Ophiomyxa australis Lütken
Ophiacantha alternata sp. nov.
Amphipholis squamata (D. Chiaje)
Amphiura constricta Lyman
Amphiura poecila H.L.C.
Amphiura elandiformis sp. nov.
Amphiura (*Ophiopeltis*) *parviscutata* sp. nov.
Ophiocentrus pilosus (Lyman)

Ophiothrix caespitosa Lyman

Ophiocoma canaliculata Lütken

Ophionereis schayeri (M. & Tr.)
**Pectinura arenosa* Lyman
Ophiarachnella ramsayi (Bell)
**Ophiocrossota multispina* (Ljungman)
Ophiura kinbergi Lj.

Astroconus pulcher H.L.C.
Astroboa ernae Död.

Ophiacantha brachygnatha H.L.C.

Amphiura trisacantha H.L.C.

Amphiodia ochroleuca (Brock)

Ophiactis tricolor H.L.C.
Ophiactis resiliens Lyman
Ophiothrix aristulata Lyman
Placophiothrix spongicola (Stimpson)
Ophiocoma pulchra H.L.C.
Ophiocomina australis H.L.C.
Ophionereis semoni (Död.)
Pectinura assimilis (Bell)
Ophiurodon opacum H.L.C.
Ophioplocus bispinosus H.L.C.
Ophiura ooplax (H.L.C.)
Ophiozonella elevata (H.L.C.)

Echinoids:—

Goniocidaris tubaria forma *impressa* Koehler
**Microcyphus zigzag* L. Agassiz
**Microcyphus compsus* H.L.C.
**Microcyphus annulatus* Mtsn.
Amblypneustes ovum (Lmk.)

**Holopneustes porosissimus* L. Ag.
**Holopneustes inflatus* Lütken *in* A. Agassiz
Heliocidaris erythrogramma (Val.)
Pachycentrotus australiae (Michelin *in* A. Agassiz)

Phyllacanthus irregularis Mtsn.
Temnopleurus michaelseni (Död.)

Microcyphus pulchellus H.L.C.

Amblypneustes pachistus H.L.C.
Amblypneustes grandis H.L.C.
Amblypneustes formosus Valenciennes
Amblypneustes pallidus (Lmk.)

1. H. L. Clark (1946) mentions some small specimens from Port Phillip which might belong to this species.

Echinoids—*continued.*

**Clypeaster australasiae* (Gray)	*Ammotrophus cyclius* H.L.C. *Ammotrophus platyterus* H.L.C. *Peronella peroni* (L.Ag.) =*Fibularia ovulum* Lmk.
**Echinocyamus platytatus* H.L.C.	*Fibularia plateia* H.L.C. *Protenaster australis* (Gray) *Moira stygia* Lütken *in* A.Ag. *Moira lethe* Mtsn.
Echinocardium cordatum (Pennant)	*Brissus meridionalis* Mtsn. *Eupatagus valenciennesi* L.Ag.

Holothurians:—

Stichopus mollis (Hutton)	*Stichopus ludwigi* Erwe *Holothuria hartmeyeri* Erwe
Pentacta australis Ludwig	*Cucumaria striata* Joshua & Creed
Stereoderma sp.	'*Cucumaria squamatoides* H.L.C.'—a nomen nudum
Staurothyone inconspicua (Bell)	
Thyone nigra J. & C.	*Staurothyone vercoi* (J. & C.) *Neoamphicyclus lividus* Hickman
Cucumella mutans (Joshua)	*Amphicyclus mortenseni* Heding & Panning *Lipotrapeza ventripes* (J. & C.) *Lipotrapeza vestiens* (J.) *Neothyonidium dearmatum* (Dendy & Hindle) *Psolidium* sp.
Paracaudina australis (Semper)	*Paracaudina tetrapora* (H.L.C.)
Leptosynapta dolabrifera (Stimpson)	*Leptosynapta ictinodes* H.L.C. *Chiridota gigas* Dendy & Hindle
Trochodota allani (J.)	*Trochodota roebucki* J.

5. Notes on the nomenclature of this and some other species are given in the relevant keys.

SPECIES OF ECHINODERMS COLLECTED BY J. B. WILSON AT PORT PHILLIP AND RECORDED BY BELL, 1888 [with the accepted name (where different) on the right].

Antedon Wilsoni sp. nov.	*Aporometra wilsoni* (Bell)
Antedon incommoda sp. nov.	Same
Actinometra trichoptera Müller	*Comanthus trichoptera* (Müller)
Asterias calamaria Gray	*Coscinasterias calamaria* (Gray)
Plectaster decanus M. & Tr.	Same
Nectria ocellata Perrier	=*Nectria multispina* H. L. Clark*
Tosia grandis Gray	*Tosia magnifica* (M. & Tr.)
Polmipes sp.	Not traced; one labelled '*Asterina*' is *Paranepanthia grandis* (H.L.C.)
Asterina Gunni Gray	*Patiriella gunni* (Gray)
Patiria crassa Gray	=*Austrofromia polypora* (H.L.C.)
Astropecten pectinatus Sladen	Same
Pectinura arenosa Lyman	Same
Ophiothrix sp.	*Ophiothrix caespitosa* Lyman
Ophiomyxa australis Lütken	Same
Goniocidaris geranoides Lamarck	*G. tubaria* forma *impressa* Koehler
Amblypneustes ovum Lamarck	Same
Microcyphus zigzag Agassiz	Some are *M. compsus* H.L.C. or *annulatus* Mortensen
Strongylocentrotus tuberculatus Lamarck	*Heliocidaris tuberculata* (Lamarck)
Strongylocentrotus sp. (juv.)	*Pachycentrotus australiae* (Agassiz)
Lovenia elongata Gray	Not traced; some labelled *Echinocardium australe* are *E. cordatum*
Molpadia sp.	*Paracaudina australis* (Semper)
Cucumaria inconspicua sp. nov.	*Staurothyone inconspicua* (Bell)
Colochirus australis Ludwig	*Pentacta australis* (Ludwig)
Holothuria, 2 or 3 species	*Stichopus mollis* (Hutton)

* An equals sign (=) signifies a mistake in identification by Bell, other changes of specific name are due to synonymy.

PORT PHILLIP ECHINODERMATA COLLECTED BY THE SURVEY 1957–63.

(With a few brief notes on some of the commonest species by J. Hope Macpherson).

Figures in brackets are the station numbers as shown on Chart 2.

CRINOIDEA—

Comanthus (Cenolia) trichoptera (J. Müller).
Areas 50 (267); 59 (36); 61 (37).

Aporometra wilsoni (Bell).
Area 58 (151).

Euantedon paucicirra H. L. Clark.
Areas 50 (233); 61 (241). Species new to Port Phillip.

Antedonid sp.
Areas 58 (150–4); 59 (36).

Antedon incommoda Bell.
Areas 58 (290); 59 (24, 36).

Antedon loveni Bell.
Areas 30 (10); 58 (151); 61 (37).

ASTEROIDEA—

Tosia australis Gray.
Areas 5 (168); 6 (65, 137); 7 (123); 10 (11, 103); 13 (82, 92–4); 14 (95); 20 (124); 27 (41); 28 (140); 29 (107); 30 (10, 280); 36 (75); 37 (40); 40 (101); 42 (38); 55 (39, 148); 58 (79); 59 (24); 61 (37); 62 (99); 63 (164); 68 (155, 218).

Tosia magnifica (Müller & Troschel).
Areas 5 (168); 10 (193); 13 (92); 16 (283); 18 (308); 19 (306); 22 (119, 120–1); 28 (315); 30 (280); 31 (273, 276); 39 (42); 42 (281); 55 (147); 63 (159); 69 (221).

Occurs in deeper water with a sandy-mud or mud bottom.

Pentagonaster duebeni Gray.
Areas 66 (292); 59 (36).

Nectria macrobrachia H. L. Clark.
Area 66 (292).

Nectria ocellata Perrier.
Area 59 (24).

New record for Port Phillip.

Nectria multispina H. L. Clark.
Areas 58 (150–4); 59 (24); 66 (—).

Petricia vernicina (Lamarck).
Areas 6 (65, 137); 15 (53); 24 (Mordialloc); 26 (41); 37 (40).

Austrofromia polypora (H. L. Clark).
Area 66 (292).

Patiriella calcar (Lamarck).
Areas 6 (118); 10 (103); 26 (126); 27 (41); 38 (127); 48 (34).

The most common starfish on the Victorian coast and occurring under stones at low tide on reefs in Port Phillip. Also it does occur in water up to several fathoms on offshore reefs.

Patiriella gunni (Gray)
Areas 14 (5); 26 (126, 300); 27 (41, 284); 30 (10); 39 (43, 47); 40 (101); 42 (38, 281); 50 (229, 230); 58 (81, 150–4); 59 (24).

Less common than *Patiriella calcar* but with a similar habitat in the intertidal zone and also occurring in deep water.

ASTEROIDEA—*continued.*

Paranepanthia grandis (H. L. Clark).
Area 14. (Ricketts Point.)

Nepanthia hadracantha sp. nov.
Area 66 (292).

Plectaster decanus (Müller & Troschel).
Area 66 (292).

Coscinasterias calamaria (Gray).
Areas 6 (137); 13 (93, 95); 16 (142); 26 (126, 301); 27 (41); 28 (315); 30 (10); 38 (127); 39 (47, 312), 40 (101); 42 (108); 43 (303); 48 (34); 55 (39); 59 (36); 61 (37); 63 (161, 164).

Very common on sand and sandy-mud areas often associated with *Ostraea* beds.

Allostichaster polyplax (Müller & Troschel)
Areas 5 (52); 6 (137); 9 (178); 10 (103); 11 (191); 27 (41); 49 (284); 29 (108); 30 (10); 40 (101); 42 (38); 55 (39); 59 (24, 36); 61 (37).

Common in low tide rock pools and also on reefs in deeper water.

Uniophora granifera (Lamarck).
Areas 10 (103); 23 (7); 27 (139); 42 (38, 281); 55 (39); 59 (24); 63 (163).

OPHIUROIDEA—

Ophiomyxa australis Lütken.
Areas 26 (41); 27 (141); 59 (24, 36).

Ophiacantha alternata sp. nov.
Areas 6 (137); 15 (284); 50 (233); 58 (150–4); 59 (36).

Ophiactes resiliens Lyman.
Area 58 (290).

Four of the ten half-jaws have three rather than two distal oral papillae.

Amphipholis squamata (Delle Chiaje).
Areas 6 (118, 137); 23 (68); 32 (277); 58 (150–4); 59 (36); 61 (37).

Amphiura constricta Lyman.
Areas 7 (123); 11 (191); 12 (196, 198); 14 (117); 18 (59); 19 (304); 23 (71); 30 (10); 40 (101); 42 (108); 47 (30); 55 (145); 58 (150–4); 59 (24); 59 (36); 59 (214); 61 (37); 63 (164); 67 (216); 69 (96).

Amphiura poecila H. L. Clark.
Area 60 (96).

Amphiura elandiformis sp. nov.
Areas 7 (207); 13 (210); 20 (309); 21 (115); 23 (68); 32 (277); 33 (177); 35 (72); 43 (251, 263); 47 (258–9); 52 (252); 53 (253); 61 (241); 63 (246).

Amphiura (Ophiopeltis) parviscutata sp. nov.
Areas 25 (299); 26 (126); 27 (302); 39 (312); 55 (147).

Ophiocentrus pilosus (Lyman).
Areas 26 (126, 311); 27 (48); 29 (289); 39 (45, 312); 68 (220).

Ophiothrix caespitosa Lyman.
Areas 50 (233); 57 (294); 58 (150–4); 59 (24, 36, 79, 87, 214); 61 (239); 66 (292).

Ophiothrix sp. juv., prob. *caespitosa.*
Area 50 (234).

Ophiocoma canaliculata Lütken.
Areas 55 (22); 59 (24).

Ophionereis schayeri (Müller & Troschel).
Areas 11 (191); 59 (24).

The common intertidal species; specimens from shallow water are always smaller than those from Portsea Pier. Area 59 (24.)

Ophiarachnella ramsayi (Bell).
Area 59 (24).

Ophiura kinbergi Ljungman.
Areas 43 (251); 62 (96).

ECHINOIDEA—

Goniocidaris tubaria forma *impressa* Koehler.
Area 59 (36).

Heliocidaris erythrogramma (Valenciennes).
Areas 6 (65, 137); 10 (103); 13 (93, 95); 16 (143); 27 (41); 30 (280); 31 (10); 37 (40); 42 (38, 281); 48 (34); 55 (39, 148); 58 (150–4); 59 (24); 61 (37); 63 (164); 69 (221).

A common species under rock ledges just below low tide on most rock platforms in Port Phillip. The commonest species of urchin along the whole Victorian coast line. Colour varies from a light pinkish mauve to the deep purple which is predominant in most areas.

Amblypneustes ovum (Lamarck).
Areas 5 (169); 18 (60); 27 (41); 31 (10); 39 (42); 42 (38).

Pachycentrotus australiae (Michelin).
Area 58 (293).

Echinocardium cordatum (Pennant).
Areas 6 (65, 200); 7 (123, 208); 10 (14, 194); 11 (190); 12 (111, 112, 196, 211); 13 (83, 92, 210); 18 (186, 307); 19 (304); 20 (124, 309); 21 (115); 22 (119; 23 (2); 29 (287); 32 (277); 35 (71); 39 (46, 314); 43 (251, 263, 274); 47 (28); 52 (252): 54 (254); 55 (146); 59 (36); 62 (244); 63 (159, 246); 68 (220).

A very common animal in suitable environment of sandy mud. It is one of the few species found in the central mud area of the bay within the 10-fathom line.

HOLOTHURIOIDEA—

Stichopus mollis Hutton.
Areas 5 (166); 6 (63–4); 7 (123, 208); 10 (14, 103, 193–4); 11 (125); 12 (110–3); 13 (92); 16 (283); 18 (187, 308); 19 (306); 25 (129); 26 (126); 27 (41); 28 (139, 285); 29 (109, 287); 31 (10, 273); 35 (73); 37 (279); 38 (127); 39 (42, 49, 314); 40 (101); 42 (38): 43 (274); 51 (270); 55 (148); 63 (18, 164); 68 (157, 220).

Pentacta australis (Lüdwig).
Areas 5 (52, 68); 6 (65, 137); 10 (11); 11 (125); 12 (110–3); 22 (119); 27 (49); 36 (75, 77); 55 (148); 56 (295); 60 (214); 61 (37); 63 (159).

Stereoderma sp.
Area 61 (37).

Staurothyone inconspicua (Bell).
Areas 58 (150–4); 61 (37).

Thyone nigra Joshua and Creed.
Areas 26 (300–1); 27 (41, 302).

Cucumella mutans (Joshua).
Areas 7 (123); 11 (125); 13 (92); 24 (Mordialloc; 26 (300–1); 27 (41); 28 (285); 36 (75, 77); 42 (38); 55 (39, 148); 59 (25); 63 (164).

Paracaudina australis (Semper).
Areas 68 (Rye Pier); 69 (Rosebud Pier).

Living in sand in approximately 20 feet of water.

Leptosynapta dolabrifera (Stimpson).
Areas 12 (196); 18 (308); 19 (306); 20 (309); 21 (115); 22 (119); 26 (126); 27 (302); 28 (285); 36 (78); 55 (145).

This species is associated with *Trochodota allani* in the central mud basin, within the 10-fathom line of Port Phillip, but is less common than the latter species.

Trochodota allani (Joshua).
Areas 11 (212); 12 (110–3, 196, 211); 13 (210); 21 (115); 33 (177); 51 (270); 55 (145); 59 (213).

A very common species in deep-water areas with a mud bottom. It is one of the dominant animals within the 10-fathom line of Port Phillip.

ADDITIONAL RECORDS OF ECHINODERMS FROM VICTORIA AND BASS STRAIT.

(From material sent by Miss J. H. Macpherson.)

Plectaster decanus (M. & Tr.)	Cape Schank	1
Pentagonaster duebeni Gray	„ „	3
Nepanthia hadracantha sp. nov.	„ „	4
Nectria multispina H. L. C.	„ „	2
Nectria macrobrachia H. L. C.	„ „	5
Nectria ocellata Perrier	Portland	1
Paranepanthia grandis H. L. C.	Flinders, Western Port	1
Petricia vernicina (Lamarck)	Merricks, Western Port	2
Petricia vernicina (Lamarck)	Flinders I., Bass Strait	3
Tosia australis Gray	Flinders I., Bass Strait	1
Uniophora granifera (Lamarck)	Stoney Point, Western Port	1
Astroconus australis (Verrill)	Off C. Woolamai, Phillip Is.	1
Ophiacantha alternata sp. nov.	Flinders, Western Port	2
Paracaudina australis (Semper)	Flinders I., Bass Strait	1
Lipotrapeza vestiens (Joshua)	Shoreham, Western Port	2

NOTE.—In the artificial keys that follow, together with details of certain species, the arrangement and dichotomies are often unnatural, having been chosen as the simplest and most obvious ones for students unfamiliar with the more obscure features of echinoderm morphology. If more nearly natural keys are required, H. L. Clark's 'Echinoderm fauna of Australia' is available, but in some cases I have found this to be a little misleading, particularly due to his frequent use of the alternative 'Not as above'. There are also one or two mistakes, notably in his key to the genera of the family Asteriidae (p. 154); the secondary division, B and BB, is derived from Fisher's key in the Asteroidea of the North Pacific but omits the final alternative 'or absent' in BB, so implying that pedicellariae are invariably present on the adambulacral spines in *Smilasterias*, *Allostichaster*, *Cosmasterias* and *Uniophora*. In fact such pedicellariae are absent in these genera. Also in *Smilasterias* and *Allostichaster* the size is rarely sufficiently great for there to be more than one series of actinal plates. Notwithstanding this and a few other minor errors, Dr. Clarks' monumental work is an immensely useful one. However, I think it is worth while to include here my own keys, limited as they are to the fauna of the eastern Flindersian region.

CRINOIDEA.

KEY TO THE CRINOIDS OF THE EAST FLINDERSIAN REGION.

1. (8) Proximal pinnules long, each with at least 25 short segments, the outer ones often curled up, bearing a tooth (or a pair of teeth) so that together they form a comb; mouth more or less eccentrically placed on the disc.

2. (3) Ten arms only; cirri very stout with no segments longer than broad. *Comatulella brachiolata* (Lamarck).

3. (2) More than ten arms; some of the middle cirrus segments longer than broad. *Comanthus*.

4. (5) Longest cirri almost a third as long as the arms* *Comanthus* (*Cenolia*) *plectrophorum* H.L.C.

5. (4) Cirri between a quarter and a tenth as long as the arms.

6. (7) Cirri numbering about twenty (XX) and 37 arms when the arm length is 65 mm. (in the unique holotype.)* *Comanthus* (*Cenolia*) *tasmaniae* A.H.C.

7. (6) Cirri numbering XXX or more and arms rarely exceeding 30 when their length is less than 100 mm.* *Comanthus* (*Cenolia*) *trichoptera* (Müller).

* As discussed on p. 298 I doubt whether these distinctions will stand up to the test of further material.

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Pentagonaster duebeni Gray	" "	3
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Nectria multispina H. L. C.	" "	2
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Nectria ocellata Perrier	Portland	1
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Petricia vernicina (Lamarck)	Flinders I., Bass Strait	3
Tosia australis Gray	Flinders I., Bass Strait	1
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5. (4) Cirri between a quarter and a tenth as long as the arms.

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7. (6) Cirri numbering XXX or more and arms rarely exceeding 30 when their length is less than 100 mm.* *Comanthus* (*Cenolia*) *trichoptera* (Müller).

* As discussed on p. 298 I doubt whether these distinctions will stand up to the test of further material.

Comanthus (Cenolia) trichoptera (J. Müller).

Comatula trichoptera J. Müller, 1846, p. 178.

Actinometra trichoptera: Bell, 1888, p. 404; Carpenter, 1890, p. 135.

Comanthus trichoptera: A. H. Clark, 1909, p. 30; H. L. Clark, 1928, p. 367; 1938, pp. 28–29.

Comanthus (Cenolia) trichoptera: A. H. Clark, 1931, pp. 579–586, pl. 3, fig. 4, pl. 74, fig. 203.

Cenolia trichoptera: H. L. Clark, 1946, p. 37.

MATERIAL.—Port Phillip Survey: Areas 59 (36) 12 + 8 specimens; 61 (37), some detached arms; 50 (267). There are also a number of specimens from Port Phillip and Port Phillip Heads collected by J. B. Wilson.

REMARKS.—All the specimens from the survey are large, while those collected by Wilson are mostly small, only one being intermediate in size.

Table 1 shows that the number of arms ranges from 17 (in a specimen with arm length between 30 and 40 mm.) to 42, but the specimens with the longest arms (up to 230 mm.) tend to have less than the maximum number, so that in order to assess the comparative sizes of the specimens it is necessary to take the product of arm length and number. Most of the smallest specimens have about 20 arms, though on some of them a few IIBr series are lacking and the number falls below twenty.

Another variant is the size of the dorsal pole of the centrodorsal, which was also noted by A. H. Clark (1931) in some specimens from Port Jackson. There seems to be a form exemplified by the two specimens marked with an asterisk in the table, in which the number of arms remains relatively small but the arms themselves grow very long and stout while the centrodorsal is thicker and less discoidal than usual, the dorsal pole being narrower and the cirrus sockets arranged in more than two rows around the sides. At the other extreme, the centrodorsal is very low, distinctly pentagonal in outline and fringed by only one staggered row of cirri. In either case the centre of the dorsal pole may be more or less sunken.

As usual, the cirrus segments increase in number with growth and also in coarseness, the ratio of length to median breadth of the longest segment (usually the fourth or fifth) ranging from 3·0/1 in smaller specimens to as little as 1·1/1 in larger ones. The maximum number of segments observed in these specimens is 30.

The largest specimens of *Comanthus trichoptera* recorded by H. L. Clark had an arm length of little over 100 mm., the number of arms ranging from twelve to 21 and the number of cirrus segments from fourteen to 21. A. H. Clark recorded a specimen (from an unknown locality) with the arm length 130 mm. He gave the cirrus segments as up to twenty and their length as up to 12 mm.

The only appreciably larger specimens of the subgenus *Cenolia* recorded from Australia are those which have been attributed to *Comanthus plectrophorum* described by H. L. Clark in 1916 from two specimens taken in the Bass Strait in 183–548 metres. These had 40 to 44 arms, the centrodorsal about 10 mm. in total diameter and 6 mm. across the dorsal pole, LV–LX cirri, with 29 to 37 segments, usually about 32, some of the proximal segments being longer than broad. The basal segments of the proximal pinnules he said are "conspicuous for their flaring, spinulose margins, which are prolonged on the aboral side into remarkable spinulose spurs."

TABLE 1.

Species	B.M. Registered Number or Locality of Other Record	Number of Arms	Arm Length (mm.)	Arm Breadth (mm.) At First Syzygy After II. Br Series	Arm Breadth (mm.) At First Syzygy After III. Br Series	Centrodorsal Diameter at Dorsal Pole (mm.)	Cirri Number	Cirri Segments	Cirri Length (mm.)	Longest Cirrus Segment 1 : br
C. trichoptera ..	1885.11.19.101 ..	17	c.35	1·0	..	1·4	XXVIII	15	5	2·2 : 1
	1885.11.19.102 ..	18	..	1·0	..	2·0	XXXIII	16	7	3·0 : 1
	1885.11.19.103 ..	20	50	1·2	..	2·5	XXX	16	7	2·3 : 1
	1887.12.6.12	20	50	1·25	..	2·3	LV	18	9	2·8 : 1
	1885.11.19.104 ..	20	..	1·25	..	2·0	XXXV	17	8	2·8 : 1
	1888.11.9.129* ..	16 (?17)	c.55	1·5	.	1·3	XLII	18	8	2·0 : 1
	1893.7.8.1	21	..	1·4	..	2·5	XXX	19	9	2·0 : 1
	1884.11.12.4	26 (?28)	..	1·7	.	3·75	c. XL	20	12	2·1 : 1
	1885.11.19.105* ..	19	c.80	1·9	..	2·0	XXXVIII	20	15	1·5 : 1
	1961.9.11.65	28	150	3·2	2·6	..	..	25	26	1·4 : 1
	1961.9.11.66	39	110	.	2·7	10·0	L +	27	30	1·3 : 1
	1961.9.11.67	37	120	..	2·0	6·5–7·0	XXXIII	20	17	1·5 : 1
	1961.9.11.64*	26	230	3·0	2·6	4·5	L +	24	20	1·2 : 1
	1961.9.11.68	40	170	..	2·8	9·0	LVII	26	30	1·1 : 1
	1961.9.11.69	31	220	3·2	.	6·0	..	25	24	1·2 : 1
	1961.5.9.100	39	..	3·2	2·8	8·0	LXXX	25	24	1·2 : 1
	1961.9.11.70 (pt.) .	42	170	3·0	2·8	8·5	LV	30	27	1·2 : 1
	1961.9.11.70 (pt.) ..	36 (?39)	205	3·2	2·6	9·0	LV	28	28	1·1 : 1
	Broughton I.	20	90	..	..	..	XXVI	21	12	..
	Port Jackson (Mtsn.) ..	30	80	.	..	3·5	XXXIV	17	9	..
	Holotype: S.W. Aust. ..	20	small	..	..	..	XXX	15	..	..
C. plectrophorum ..	Types	40–44	100	..	..	c.5	LV–LX	37	..	1·1 + : 1
	Gippsland .. .	39	130	..	..	4	XL	30	40	1·5 : 1
C. tasmaniae ..	Holotype	37	65	..	..	4	XX	16	10	2·5 : 1
C. novaezelandiae ..	Holotype	20	..	..	..	5	XIII +	17	11	2·5 : 1
	1938.12.7.194	12 (?13)	35	0·8	..	1·3	XVIII	14	6	1·8 : 1
	1938.12.7.195 (pt.) ..	17	90–110	2·2	..	4·5	XXXV	18	14	1·6 : 1
	1938.12.7.195 (pt.) ..	16 (?17)	80	1·8	..	3·7	XXXV	20	14	1·6 : 1
C. benhami ..	Holotype	28	115	..	.	..	L.	27	25	..

Some measurements and counts of specimens of the subgenus *Cenolia* of *Comanthus* from southern Australia and New Zealand. (All the specimens of *C. trichoptera* from the B.M. collections are from Port Phillip except for number 1888.11.9.129, which is from Port Jackson. When some of the division series are broken, the possible maximum number of arms is given in brackets. The measurements of arm breadth and the proportions of the longest cirrus segments were made with a micrometer eyepiece, the latter being the median lengths and breadths.)

In 1931 A. H. Clark described, under the name of *C. plectrophorum*, a specimen from off the Gippsland coast, eastern Victoria in 274–475 metres. This had 39 arms 130 mm. long and XL cirri with up to 30 segments, their length from 35 to 40 mm., the fifth to seventh segments being half again as long as broad. He described the basal segments of the pinnules that arise from the division series (i.e. PD and PP) as bearing "high carbinate processes which are usually shaped like a thick T". On P_1 he said the processes on the second and third segments are "more or less T-shaped with a more or less sharp crest parallel to the axis of the pinnule. His photograph of a detached pair of arms (1931, pl. 23, fig. 62) shows that the pinnule arising from the division series has the crest of each proximal segment simply squared off, but this gives way on the arm pinnules to the usual flared, triangular crest that is found in most specimens of *C. trichoptera*.

The large Port Phillip specimens do not show peculiar squared-off crests on these basal pinnules, instead they have the dorsal side of these segments forming only a very slight rounded keel. However, the other proximal pinnules agree with H. L. Clark's description of the types of *plectrophorum*, since they have some of the segments markedly flared and spinous. Probably there is some variation in the extent of this modification in the species of the subgenus *Cenolia*. The numbers of segments in PD, PP and P_1 in one of these large specimens are respectively 78, 69 and 72 in one series counted, each with 20–24 outer segments forming the comb. This agrees with H. L. Clark's count of over 70 in PD in the types of *plectrophorum*. However, the numbers of pinnule segments are not usually significant in distinguishing the species of *Comanthus*, being correlated with size rather than with specific differences. A. H. Clark gives the number in PD of *Comanthus trichoptera* as only 30–35 with but nine forming the comb, however, this is at a size of 60–100 mm. arm length. In the ninth specimen in Table 1, with the arm length about 80 mm., the number of segments is about 40 and some 15 form the comb.

The other four specimens from off Gippsland identified as *Comanthus plectrophorum* by A. H. Clark, had 40, 38, 31 and 27 arms with the cirrus segments numbering respectively 29–30, 34–38, 18–21 and 28–32. Although the small number of cirrus segments in the third one brings it into the range supposed to be characteristic of *C. trichoptera*, the available data suggests that *C. plectrophorum* may be distinguished by the relatively large size of the cirri as well as their more numerous segments. The second of the Gippsland specimens has some cirri as much as 50 mm. long, whereas 30 mm. is the greatest length observed in the specimens I have attributed to *C. trichoptera*.

Three other temperate Australasian species of the subgenus *Cenolia* are currently recognized. These are *C. tasmaniae*, *C. benhami* and *C. novaezealandiae* (the last two both from New Zealand), all described by A. H. Clark.

Only two specimens of *C. tasmaniae* are known; both were taken at an unrecorded depth off Tasmania; the one described had 37 arms 65 mm. long and XX. cirri with 14–16 segments, the longest segments two and a half times as long as broad. A. H. Clark distinguished *tasmaniae* from *C. trichoptera* by the number of cirrus segments, which is 14

to 17, as opposed to "about 20" segments in *trichoptera*. The number is a little less than in the available specimens of *C. trichoptera* of similar size, but hardly significantly so. However, the small number of cirri and the relatively large number of arms may provide a significant distinction for *C. tasmaniae*, though I think that a really good series of specimens from the Bass Strait area will show that it comes within the range of variation of *C. trichoptera*. A similar doubt as to its validity was expressed by H. L. Clark.

As for the New Zealand species, *C. benhami* from the southern end and *C. novaezealandiae* from the northern, they are supposed to be distinguished from each other by the number of arms and cirri, which are both larger in *C. benhami*. Besides the type specimen of *C. benhami*, which had 28 arms, Mortensen (1925) records another with probably 38. So far no examples of *C. novaezealandiae* with more than 20 arms are known; of Mortensen's six, three had twenty and the others 18 or 19, while the "Discovery" specimens shown in Table 1 have only 17 or less, though one of them is almost equal in arm length to the holotype of *C. benhami*. Both species are clearly related to *C. trichoptera*, but it remains to be seen, when there is sufficient material available for a proper appreciation of the ranges of variation, whether or not they can be maintained as distinct. In A. H. Clark's key (1931, p. 531), *C. benhami* was distinguished from *trichoptera* by its larger cirri with 24–27 segments as opposed to about 20. The data given in the table, particularly for specimens 1961.9.11.65 and 66, show that the numerical characters of the holotype of *C. benhami* come within the range of variation of *C. trichoptera*. Whether there are any other characters by which the form from southern New Zealand may be distinguished remains to be seen from fuller descriptions of the existing and any additional material. The same key differentiated *trichoptera* and *novaezealandiae* again on the number of cirrus segments, not more than 17 in the latter. Here too, the table shows that this difference is probably not significant. The dorsal profile of the proximal pinnules, especially the genital ones, is extraordinarily spiky in the "Discovery" specimens of *C. novaezealandiae*, as shown also in Mortensen's figure (1925, fig. 65, p. 388), but if *C. plectrophorum* proves to be synonymous with *C. trichoptera*, then the ornamentation of these pinnule segments must be very variable and this character may not carry any weight.

Antedonid sp.

Fig. 1.

MATERIAL.—Port Phillip Survey: Areas 58 (150–4), 2 specimens; 59 (36), 7 specimens.

DESCRIPTION.—The centrodorsal is low hemispherical, 1·8 mm. in total diameter and 0·9 mm. across the dorsal pole, which is slightly convex and irregularly pitted. There are approximately XXXV cirri, which arise at about three levels around the sides and appear to alternate when seen in dorsal view. The longest peripheral ones have fifteen segments and measure about 7·5 mm. in length. The first two segments are short, the third has length to median breadth 1·4 : 1, the fourth is relatively the longest with length to breadth 1·9 : 1 while the fifth and sixth are slightly longer, each about 1·3 mm., but wider dorso-ventrally since the third to the tenth segments are all flared, both dorsally and ventrally, from near

their proximal ends right to their distal ends. The eleventh to thirteenth segments are almost rectangular in side view, the thirteenth (antepenultimate) segment having length to breadth 1·2 : 1, the breadth being half as much again as that of the third segment. The opposing spine is well developed and the terminal claw is stout, curved and about as long as the penultimate segment. In dorsal view the cirri appear hardly expanded at the joints, unlike those of *Antedon incommoda*.

The apical cirri are shorter with about thirteen segments and measure about 4·5 mm.; their terminal claws are relatively longer.

The adjacent division series are widely separated. The IBr_1 are short, almost occluded in the middle by the proximal angle of the axillary and tapering distally so that the joint between the two ossicles is constricted. The axillaries are wider and rhombic with the four sides concave; the maximum breadth is located near the middle of the length, the ratio of length to breadth being 1 : 1·25.

The arms are about 25 mm. in length. The breadth at the first syzygy (brachials 3 + 4) is 0·85 mm. and the length from the proximal edge of the IBr_1 to the second syzygy (at brachials 9 + 10) is 5·0 mm. Like the axillary, the second brachial has a marked proximal angle.

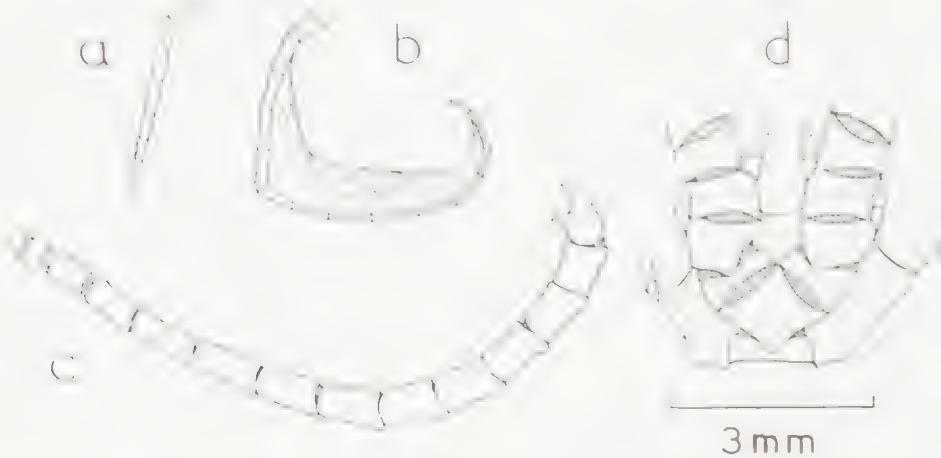

Fig. 1. Antedonid sp., Lonsdale Bight, Port Phillip, **a** P_1, **b** P_2, **c** cirrus and **d** a division series and the bases of two arms.

P_1 has nine or ten segments, the first two short and the rest longer than broad; it tapers evenly and measures 2·8 mm. in length. P_2 is much larger with fifteen to eighteen segments, all but the first one much longer than broad and most of them slender but expanded at the joints. It is the first genital pinnule and the long gonad, within which the large oval eggs can be seen, extends from the fourth segment to the thirteenth. The terminal part of the pinnule is very slender. The length of P_2 is about 5·8 mm. P_3 and P_4 are the last genital pinnules and are similar in size to P_2. The distal pinnules are long. P_{11} has seventeen segments, all but the first one longer than broad, the longest having length to breadth 2·5 : 1; the pinnule measures 4·2 mm. in length. There are no ambulacral spicules.

The sacculi are not conspicuous.

On the disc the anal cone is very large and the mouth is displaced away from the centre.

The colour is reddish (after a year in spirit).

Some numerical details of this and seven other specimens are given in Table 2, the one described being the last one.

REMARKS.—This species appears to be referable to the subfamily Antedoninae, judging from the form of the cirri, which are very like those of *Antedon loveni;* the low hemispherical centrodorsal also supports this. However, the abruptly larger P_2 and the fact that it is the first genital pinnule suggest an affinity with the Bathymetrinae, a subfamily only known from deeper water, few of its species being found in depths of less than 50 metres. Until larger specimens are available to help clarify its relationship, it seems to me better that this species should go unnamed.

Euantedon paucicirra H. L. Clark.

Euantedon paucicirra H. L. Clark, 1928, pp. 369–370, fig. 109.

MATERIAL.—Port Phillip Survey: Areas 61 (241), 1 specimen; 50 (233), 1 specimen.

REMARKS.—Both specimens (as preserved in spirit) are predominantly purple in colour with a tendency to banding on the arms; the numerous sacculi along the pinnules are quite pale. One specimen has the disc exposed and conspicuously orange-red.

The arms are about 30 mm. long in both and the breadth at the first syzygy is about 0·5 mm. The centrodorsal is rounded with only a small bare dorsal pole. The more nearly intact specimen has about XXVIII cirri which are very slender, the longer ones with seventeen segments, the antepenultimate one just longer than broad. The cirri are much like those of *Antedon loveni* except for the additional segments. Both specimens have P_2 only two-thirds to three-quarters the length of P_1 which is about 1·2 mm. long, but in one specimen P_1 has only seven segments and P_2 eight while the other has nine segments in P_1 and seven in P_2. P_3 is the first genital pinnule and has nine or ten segments; the rather short gonad extends from the third to the sixth segments.

In H. L. Clark's type specimen from St. Vincent Gulf the size was slightly larger, the arms being 40 mm. long. This may account for the larger number of cirrus segments, 17–26, usually about 20, the cirri themselves numbering XXV. The proximal pinnules are considerably longer than in the Port Phillip specimens, P_1 being 5–7 mm. long with 10–12 segments and P_2 about 3·5 mm. with 7 segments. P_3 is again the first genital pinnule. The development of the proximal pinnules may be retarded in some species of macrophreate comatulids, which may account for their relatively small size in the present material, but more material is needed to show the range of variation and the growth changes of the species.

It is not impossible that the Port Phillip specimens I have identified as *Antedon loveni* are conspecific with these two; certainly their proximal pinnules are very similar. However, the fact that no more than 14 cirrus segments were found in the former, even at an arm breadth of 0·7 mm. suggests that they are distinct.

TABLE 2.

B.M. Registered Number	Br at 3 + 4 (mm.)	L to 9 + 10 (mm.)	Cirri		P_1		P_2	
			Segs.	Length (mm.)	Segs.	Length (mm.)	Segs.	Length (mm.)
Antedon loveni								
93.7.8.6 (pt.) ..	0·3	2·8	10, 11	3·3	6	1·2	5, 6	1·0
1962.4.9.1	0·35	3·0	12, 13	3·8	8, 9	2·0	7, 8	1·5
93.7.8.15 (pt.) ..	0·4	2·8	12, 13	5·3	7, 8	1·4	6	1·0
1961.9.11.71 (pt.) ..	0·5	3·5	14	5·8	8, 9	2·5	7	1·5
1961.9.11.71 (pt.) ..	0·5	3·7	14	5·0	9	2·6	7	2·0
93.7.8.6 (pt.) ..	0·6	3·5	12	4·8	7	2·4	7	1·6
93.7.8.15 (pt.) ..	0·6	3·5	12, 13	5·0	7	2·2	7	1·8
93.7.8.6 (pt.) ..	0·6	3·5	13	5·5	8, 9	2·6	7, 8	1·7
83.12.9.69 S ..	0·65	4·0	13	5·5	9, 10	3·5	7	1·8
93·7·8·6 (pt.) ..	0·7	4·5	14	4·8	9	3·1	8	2·1
Antedon incommoda								
1961.9.11.89 ..	0·3	2·7	13	3·7	6	1·2	6	0·9
1961.9.11.85 ..	0·35	2·4	11	2·9	6, 5	1·0	5	0·8
1961.9.11.84 ..	0·35	2·9	12	..	6	1·2	6	1·0
1962.4.9.2 (pt.) ..	0·4	3·0	12	4·0	7, 8	1·6	5, 6	1·2
1961.9.11.83 ..	0·4	3·0	13	3·8	6, 7	1·5	6	1·1
1962.4.9.2 (pt.) ..	0·45	3·5	12	3·5	7	1·8	6, 7	1·3
1961.9.11.86 ..	0·45	3·0	13	..	7	1·7	6	1·2
1961.9.11.87 ..	0·45	..	13	4·3	..	..	..	..
1961.9.11.90 ..	0·6	4·4	13	5·8	14, 15	4·2	8	1·7
87.12.6.13 S ..	0·7	5·0	12	6·0	17	5·5	8	2·0
87.12.6.13 S ..	0·8	5·3	13	..	15, 16	5·0	8	2·0
1962.4.9.2 (pt.) ..	0·8	4·5	13	..	{ 16	6·4	8	2·4
					{ 9	3·5	7	1·6
1961.9.11.91 ..	0·9	..	15	6·8	18, 20	6·1	9	2·1
84.11.12.5 (pt.) S ..	0·9	5·5	13	6·5	16	6·0	9	2·3
84.11.12.5 (pt.) S ..	0·9	5·5	13	7·0	..	..	9	2.3
93.7.8.2	0.9	5.5	13	7.0	16	4·5	8	2·0
93.7.8.3	0·9	5·5	13	7·0	15	..	8	2·2
87.12.6.13	0·9	6·0	13	7·5	16	6·0	9	2·5
1961.9.11.88 ..	1·0	5·3	13	5·5	15 ;	5·3—	9	2·2
93.7.8.4	1·0	5·5	14	8·0	17	6·5	9	3·0
1961.9.11.92 ..	1·1	..	14	7·1	15	5·3	9	2·9
84.11.12.6 S ..	1·1	6·0	14	8·0	24	10·0	12	4·5
1961.5.9.101 ..	1·1	5·3	14	8·7	20	6·6	8	2·6
1961.9.11.72 ..	0·35	2·5	12	3·0	7	1·3	7	1·0
1961.9.11.73 ..	0·4	3·0	..	..	6	1·3	5	1·0
1961.9.11.74 ..	0·45	3·5	14	5·0	7	1·4	15	3·0
1961.9.11.75 ..	0.45	3.5	14	5.0	6	1·2	13	3·0
1961.9.11.82 ..	0·5	3·1	14	4·8	6	1·1	13	..
1961.9.11.81 ..	0·75	4·0	16	6·8	10	2·2	17	5·5
1961.9.11.76 (pt.) ..	0·75	4·5	15	6·5	10	2·1	17	5·5
1961·9·11·76 (pt.) ..	0·85	5·0	15	7·5	9, 10	2·8	18	5·8

Measurements and counts of some Antedonids. The registration numbers starting with 83, 84, 87 or 93 are of Wilson's specimens from the vicinity of Port Phillip Heads, the rest were collected by the Survey, 1961.9.11.72–76 and 83–95 also 1962.4.9.2 from Pope's Eye Annulus, 1961.5.9.101 from Pope's Eye Bank, 1962.4.9.1 from Prince George Bank, 1961.9.11.71 from Prince George Light and 1961.9.11.81–82 from Lonsdale Bight. S signifies a syntype. All the specimens are from Port Phillip except for the syntype of *Antedon loveni* which is from Port Stephens, N.S.W. The second and third columns provide an assessment of size; Br is the arm breadth at the first syzygy (to the nearest 0·05 mm.) and L the length from the proximal end of the division series to the second syzygy (to the nearest 0·1 mm.). All measurements were made with a micrometer eyepiece. The smallest specimens have an arm length of about 15 mm. and the largest about 50 mm.

Genus *Antedon* de Freminville.

In 1955, Gislén (Atlantide Rep., No. 3) referred *Compsometra* A. H. Clark (type species *Antedon loveni* Bell) to the synonymy of *Antedon*, having decided that the difference in the degree of spinous development of the pinnule segments, upon which the distinction of *Compsometra* depended, does not hold good. Two species from southern Australia are involved in the change, namely *Compsometra loveni* (Bell) and *C. incommoda* (Bell), both of which revert to their original combination with the name *Antedon*.

Both species are small and delicate, at least as collected in Port Phillip; in neither does the arm length exceed 50 mm. and the largest specimen of *A. loveni* from the bay probably had an arm length of only about 30 mm. However, sexual maturity is reached at a small size, some specimens of both species with arms probably less than 20 mm. long (when complete) having noticeable short thick gonads, those of the females with large eggs inside.

Most of the characters distinguishing *A. loveni* from *incommoda* are juvenile features, for instance the more slender cirri, smaller number of pinnule segments and the tapering rather than discoidal centrodorsal. Indeed, as Table 2 suggests, the smallest specimens with the arm breadth at the first syzygy less than 0·5 mm. are indistinguishable and can only be named by their association with others of larger size which are sufficiently divergent in the form of their cirri and pinnules. Unfortunately only two specimens of *A. incommoda* available to me are comparable in size with the material of *A. loveni* from Port Phillip that exceeds the critical size of 0·5 mm. arm breadth. Both of these have P_1 more than twice as long as P_2 and with about twice as many segments, whereas the five examples of *A. loveni* with Br. 0·6–0·7 mm. retain the juvenile relative proportions of these pinnules.

Possibly *A. loveni* can be interpreted as a neotenous form of *incommoda*, in which case the distinction between them may be at the infraspecific level.

The history of the Australian Antedons is rather involved. In 1882 Bell published the name *Antedon loveni* with a diagnostic formula which A. H. Clark accepts as sufficient indication to validate the name. However, in 1884 Bell described what was evidently this same species, on the basis of a specimen from Port Jackson, under the name of *Antedon pumila*. At the same time he transferred the name *A. loveni* to a second species, from Port Denison, Queensland, which in 1882 he had called *A. insignis;* this latter species is now called *Colobometra perspinosa* (P. H. Carpenter), 1881, *A. insignis* being a synonym. In 1910 (Proc. U.S. Nat. Mus. 38, p. 275) A. H. Clark described what he thought to be a new species from Port Jackson under the name of *Compsometra lacertosa* but in 1911 (and 1911a) he referred *lacertosa* to the synonymy of *Compsometra loveni*. The cirri of the type of *lacertosa* were relatively much smaller in comparison to the arms than in the Port Phillip specimens of *A. incommoda;* nevertheless if both species occur at Port Phillip it is probable that they also both occur at Port Jackson.

Antedon loveni Bell.

Antedon loveni Bell, 1882, p. 534; A. H. Clark and A. M. Clark, Bull. U. S. National Museum (in the press).

Compsometra loveni: A. H. Clark, 1911a, p. 442; H. L. Clark, 1946, p. 61.

MATERIAL.—Port Phillip Survey: Areas 30, (10), 3 specimens; 58 (151), 6 specimens; 61 (37), 5 small specimens. Also several others from J. B. Wilson's collection.

The type locality of *A. loveni* is Nelson's Bay, New South Wales.

Antedon incommoda Bell.

Antedon incommoda Bell, 1888, pp. 402, 404; A. H. Clark and A. M. Clark (in the press).

Compsometra incommoda: A. H. Clark, 1911a, pp. 442–444, 464, 465; H. L. Clark, 1916, pp. 5, 26; Cotton and Godfrey, 1942, p. 232; H. L. Clark, 1946, p. 60.

MATERIAL.—Port Phillip Survey: Areas 58 (290), 1 specimen; 59 (36), 18 specimens; 59, (24), 1 specimen. Also the types and other specimens in the British Museum from J. B. Wilson's collections.

The type locality of *A. incommoda* is the outer part of Port Phillip Harbour and outside the Heads.

ASTEROIDEA.

KEY TO THE ASTEROIDS OF THE EAST FLINDERSIAN REGION.

1. (24) Interbrachial areas extensive, the interbrachial arcs rounded and arms merging into the disc; body flattened more or less and the two series of marginal plates noticeable or prominent.

2. (15) Margin thick, formed by both series of marginal plates almost equally; dorsal surface flat or convex.

3. (4) A pair of large valvate pedicellariae prominent in each interradius dorsally (sometimes one or both lacking in some interradii); body smooth, plates obscured by skin in live and spirit specimens; no granules .. .. *Petricia vernicina* (Lamarck), 1816

4. (3) If any valvate pedicellariae are present then these are scattered on the dorsal and ventral plates, which are partially or completely covered with granules and not obscured by smooth skin.

5. (10) Marginal plates large and few in number, not more than eight superomarginals on each side of each arm (or sixteen across an interbrachial arc), most often only three or four; dorsal plates smooth, with only single rows of marginal granules.

6. (7) Pedicellariae present, each with two or three narrow valves less than 0·5 mm. long, normally opened out and sunk into grooves in the smooth surfaces of the dorsal and ventral plates; interbrachial arcs usually fairly deep, R/r more than 2/1. .. .. *Pentagonaster duebeni* Gray, 1847

7. (6) Pedicellariae rare or absent, occurring most often on the adambulacral plates, resembling a split granule in form, the two valves being short and wide, not sunk into elongated grooves; R/r less than 2/1, usually about 1·5/1. *Tosia*

8. (9) Three (rarely four) supero-marginal plates on each side, the distal-most one sometimes (forma *astrologorum*) conspicuously swollen; ventral plates often bare like the dorsal ones. .. .. *Tosia australis*, Gray, 1840

9. (8) Supero-marginal plates numbering three only when R is less than 12 mm., increasing in number as growth proceeds, the distal ones never conspicuously swollen; ventral plates always largely or completely granule-covered. .. .. .. *Tosia magnifica* (M. & Tr.), 1842

10. (5) *Marginal plates fairly numerous, fourteen or more (often over 20) on each side; dorsal plates high tabulate or markedly tubercular with extensive granulation.

11. (14) Dorsal plates flat-topped, the proximal ones high tabular, their free surfaces covered with a continuous layer of granules; pedicellariae with valves not much wider than long sometimes present, particularly just below the granule-crown of the proximal tabula or on the adambulacral plates. [See also no. 26]. .. .. *Nectria* (part)

12. (13) Central granules of each tabulum crowded and larger than the peripheral granules, the surface of the tabulum often convex and its outline angular; pedicellariae usually present. .. *Nectria multispina* H. L. Clark, 1928

13. (12) Central granules of each tabulum not crowded and usually similar in size to the peripheral ones, tabula with horizontal tops and rounded in outline; pedicellariae rare. [These two species seem to intergrade].
Nectria ocellata Perrier, 1875

14. (11) Dorsal plates not tabular, some bearing very convex single tubercles, others with several, in between a continuous granulation; pedicellariae valvate and very wide, more or less numerous among the granules.
Anthaster valvulatus (M. & Tr.), 1842

15. (2) Margin thin and low, formed mainly by the infero-marginal plates, the ventral surface flat and the dorsal markedly convex.

16. (17) All the abactinal plates of about the same magnitude and rhombic or oval in shape, with very fine, peripherally-placed spinelets.
Asterina atyphoida H. L. Clark, 1916

17. (16) Abactinal plates of two magnitudes, the primary ones more or less crescentic in shape, the spinelets or granules not limited to their peripheries.

18. (19) Actinal plates each bearing a cluster of fine spinelets; five-armed and growing to a large size (R up to 70 mm.) but with fairly deep inter-brachial arcs R/r being about 1·75/1. .. *Paranepanthia grandis* (H. L. Clark), 1928

19. (18) Actinal spines coarse and few; if only five arms then the size is small (R < 20 mm.) and the shape almost pentagonal .. .. *Patiriella*

20. (21) Five arms, rarely six; size small; form nearly pentagonal.
Patiriella exigua (Lamarck), 1816

21. (20) More than five arms (with rare exceptions); size often large; R up to about 50 mm.

22. (23) Seven to nine arms, usually eight; normally only one spine on each actinal plate. *Patiriella calcar* (Lamarck), 1816

23. (22) Six, sometimes seven, arms, rarely five; normally two spines on each actinal plate. .. .. *Patiriella gunni* (Gray), 1840

24. (1) Interbrachial areas small, the arcs deep and angular, arms well-defined, usually almost round in cross-section; marginal plates not conspicuous.

25. (30) Abactinal, marginal and actinal plates all covered with a continuous coat of granules or granuliform spinelets.

26. (27) Peripheral granules of the abactinal plates markedly enlarged, standing out from the surface and outlining the plates. [See also nos. 11–13 since *N. multispina* may run down to here].
Nectria macrobrachia (H. L. Clark), 1923

27. (26) Peripheral granules of the abactinal plates not conspicuously enlarged.

28. (29) Papular pores extending on the ventral side right up to the adambulacral plates; granules or granuliform spinelets low, coarse and with their tops flat or rounded. .. .. *Austrofromia polypora* (H. L. Clark), 1916

29. (28) No pores between the actinal plates; granuliform spinelets about twice as high as wide (the peripheral ones relatively higher), their tops very rugose under magnification. .. *Nepanthia hadracantha* sp. nov.

30. (25) Abactinal plates forming an open reticulum, bearing isolated large spines or else irregular spinelets or granules not forming a continuous coat.

* Young specimens of *Austrofromia polypora* with R about 30 mm. or less may run down here; they can be distinguished by the presence of ventral papulae. See p. 322.

31. (36) Two series of tube feet along each furrow.

32. (33) Abactinal plates forming a coarse reticulum with low, thick granules running along the meshes; adambulacral spines arranged in two longitudinal series. .. .. .. *Plectaster decanus* (M. & Tr.), 1843

33. (32) Abactinal reticulum indistinct, not very coarse, the meshes bearing small, pointed spines, not in continuous series; adambulacral plates with spines and spinelets forming transverse series at right angles to the furrow. *Echinaster*

34. (35) Abactinal spines in clusters, usually of five or more. .. .. .. *Echinaster glomeratus* H. L. Clark, 1916

35. (34) Abactinal spines spaced from each other. .. .. *Echinaster arcystatus* H. L. Clark, 1914

36. (31) Four series of tube feet along each furrow.

37. (40) Compact wreaths of numerous, fine, crossed pedicellariae around each of the large, isolated, sharp, abactinal and marginal spines.

38. (39) Five arms. .. .. .. *Australiaster dubius* (H. L. Clark), 1909.

39. (38) Seven to eleven arms. .. .. *Coscinasterias calamaria* (Gray), 1840.

40. (37) Crossed pedicellariae not forming compact wreaths around the abactinal and marginal spines, which are usually small and numerous, or, if large and spaced, then very blunt at the tip (in the latter case the pedicellariae are usually infrequent).

41. (42) Six to nine arms, usually unequal in size owing to regeneration, the species being self-dividing. .. .. *Allostichaster polyplax* (M. & Tr.), 1842.

42. (41) Five arms.

43. (46) Only one series of actinal plates (if any) between the adambulacrals and the infero-marginals; abactinal skeleton a close reticulum with several spinelets and pedicellariae on most plates. Size not known to exceed R 33 mm.

44. (45) Arms fairly thick, R br (the basal breadth) about 4/1; abactinal plates and spinelets forming regular longitudinal series .. .. *Allostichaster regularis* H. L. Clark, 1928.

45. (44) Arms slender, R br 6 or 7/1; no obvious longitudinal arrangement distinguishable dorsally. .. *Smilasterias irregularis* H. L. Clark, 1928.

46. (43) Two or three series of actinal plates present, though some or all of them may be spineless; abactinal skeleton a close or open reticulum, usually with coarse, very blunt spines, rarely absent; growing to a large size, R often well over 50 mm.
Uniophora [for which see H. L. Clarks' keys of 1928 and 1946].

Pentagonaster duebeni Gray.

Pl. IV, fig. 4.

Pentagonaster dübeni Gray, 1847, p. 79; 1866, p. 11, pl. 3, fig. 2; H. L. Clark, 1928, p. 380; Livingstone, 1932, pl. 44, figs. 4, 5; H. L. Clark, 1946, pp. 88–89; A. M. Clark, 1953, pp. 400–403, text-fig. 13b, pls. 43, 44.

Astrogonium crassimanum Möbius, 1859, p. 8, pl. 2, figs. 1, 2.

Pentagonaster gunni Perrier, 1875, p. 203.

Pentagonaster stibarus H. L. Clark, 1914, p. 136, pl. 17.

Pentagonaster crassimanus: H. L. Clark, 1946, pp. 89–90.

MATERIAL.—Port Phillip Survey: Areas 59 (36), 2 specimens; 66 (292), 4 specimens; Cape Schank, Victoria, 3 specimens.

The Cape Schank specimens are interesting in having the distal supero-marginal plates markedly thickened and swollen; in one specimen this enlargement is decidedly greater than in Möbius' figure of the type specimen of *Astrogonium crassimanum*. The holotype of the New Zealand species *P. pulchellus* exhibits a parallel condition. One of the three from

Cape Schank has only three supero-marginal plates on each side of each arm, whereas four or more is the usual number in this Australian species, in contrast to *pulchellus* which normally has but three. Clearly the swollen-armed form of *P. duebeni* occurs throughout its range, not just in Western Australia.

Genus *Nectria* Gray.

Pls. I, II and III. figs. 2, 3.

Nectria Gray, 1840, p. 287; 1866, p. 15; H. L. Clark, 1928, p. 379; 1946, p. 85. (Type species *Asterias ocellifera* Lamarck, 1816 [*oculifera* lapsus cal. of Gray, 1840, corrected in 1866*]).

Six species have so far been referred to this australasian genus, of which one, originally *Mediaster monacanthus* H. L. Clark, was placed here by Fisher in 1917 (Ann. Mag. Nat. Hist. (8) *20*, p. 167) and removed to a new genus *Nectriaster* created for it by H. L. Clark in 1946. The remaining species, other than the type, in chronological order are:—

Nectria ocellata Perrier, 1875

Nectria macrobrachia H. L. Clark 1923

Nectria pedicelligera Mortensen, 1925, and

Nectria multispina H. L. Clark, 1928.

Lamarck apparently included two species under the name of *Asterias ocellifera*. The second of these was referred by Perrier to a new species *Nectria ocellata* when he described the type specimen of *N. ocellifera*. Most of Lamarck's echinoderm species have proved to be common ones, but only a single record of *N. ocellifera* besides that of the type (which was from 'les mers australes?'—presumably the southern seas), is known. This record is one published by H. L. Clark in 1914 for two specimens from between Fremantle and Geraldton, Western Australia, in 60–100 fathoms (c. 110–180 metres).

The type specimen of *N. ocellifera* was figured by Oudart in a work published in 1815, according to Perrier's reference. However, in another reference to the same work, Perrier (1875, p. 296) omitted Oudart's date (as if it was only a manuscript) but gave a title—'Règne animal—Zoophytes'. The only record I can find that corresponds to this is a publication in Parish by G. Engelmann in 1826 called 'Cours d'Histoire naturelle, contenant les principales espèces du règne animal, classées méthodiquement. dessinées par Paul Oudart'. This work is not available to me but Gray evidently saw it (or Oudart's original drawing of *N. ocellifera*) since he referred to it in his works of 1840, 1847 and 1866, not only under the heading of *Nectria* but also in connection with his new species *Patiria ocellifera*. In fact he commented (1847, p. 82) that the *Patiria* species 'more nearly resembles Oudart's figure than the species

* Strictly speaking, *N. ocellata* Perrier might be considered as the type species since that is the one that Gray had before him when he diagnosed the genus *Nectria*, though he mistakenly identified it with Lamarck's species. There seems to be little likelihood that *ocellifera* and *ocellata* could ever be considered as other than congeneric so there is no point in contradicting the statement of H. L. Clark that *Asterias ocellifera* Lamarck is the type species of *Nectria*.

I have described under the name of *Nectria oculifera*'. This remark and its context imply that Gray's 1840 spelling '*oculifera*' may not after all have been a mistake and that he did think that he had a species distinct from Lamarck's, although his correction in 1866 suggests that the 1840 spelling was a *lapsus calami*. The type specimen of *Patiria ocellifera* is in the British Museum collection. A redescription and figures of it are given in A. M. Clark, (1963, Doriana, Genoa, **3** No. 127 1–1). It has a finely granulose appearance with numerous minute, forceps—like pedicellariae scattered over the whole dorsal surface and some isolated enlarged rounded primary plates on the distal parts of the arms showing up among the many small secondary ones by their slight elevation and uniform granulation. If Oudart's figure is something like this (which Perrier denies anyway), then it cannot be a very good representation of the type specimen of *N. ocellifera*. Consequently, in the absence of a readily available illustration of *N. ocellifera*, I am including here photographs of a specimen (unfortunately lacking locality data) from the collection of the Western Australian Museum (Pl. I, figs. 1–3).

Nectria ocellifera is not included in the collections from Victoria but three other species were obtained in the vicinity of Port Phillip, namely, *N. macrobrachia*, *N. ocellata* and *N. multispina*. In an attempt to assess the variation of *N. multispina* and its distinction from *N. ocellata* I found that the British Museum collection of specimens of *Nectria* from south and west Australia includes a number which are intermediate between *ocellata* and *multispina* and at the same time indistinguishable from *N. pedicelligera* Mortensen 1925, of which the type and only recorded specimen was from Gisborne in the north island of New Zealand. Also the status of *N. multispina* becomes doubtful since some of the characters by which it was distinguished are among those that are variable and do not always occur in combination. Cotton and Godfrey (1942) noted that some specimens are difficult to place as *ocellata* or *multispina*; they certainly seem to intergrade, as Table 3 suggests, though the two extremes of form are very easily recognized.

In his key to the species of *Nectria*, H. L. Clark (1928 and 1946) distinguished them by the number of furrow spines, the degree of crowding of the granules on the actinal plates, the apparent shape of the abactinal tabula and of their peripheral granules and the occurrence of pedicellariae on the actinal plates.

The low tabula of *N. macrobrachia* characterize that species and the enlargement of the peripheral granules of the proximal tabula serve to distinguish *N. ocellifera* from *ocellata* and *multispina*. The other characters I find to be variable. Nevertheless, I think there is sufficient justification for maintaining *N. multispina* distinct from *N. ocellata*, though a really good series of specimens may serve to prove otherwise.

Sluiter (1895, Bijdr. Dierk. *17*, p. 55) has recorded a specimen from Amboina in the Moluccas as *Nectria ocellifera*. I think this must be a mistake, either in locality or in identification. Sladen (1889, p. 318) also mentions a specimen from the Fiji Islands which he referred to *N. ocellifera* (i.e. to *N. ocellata* since he confused the two). H. L. Clark (1946) has already speculated on the possibility of a mistake in this locality.

Nectria macrobrachia H. L. Clark.

Pl. III, figs. 2, 3. Text fig. 2.

Nectria macrobrachia H. L. Clark, 1923, pp. 236–237, pl. 13, figs. 5, 6; 1946, p. 86.

MATERIAL.—Port Phillip Survey: Area 66 (292), 5 specimens; Cape Schank, Victoria, 5 specimens. British Museum collection, probably from J. B. Wilson; 1 specimen.

REMARKS.—At first I was inclined to refer these specimens to *Nectria ocellifera* (Lamarck) of which I believed *N. macrobrachia* must be a synonym, since the type specimen of the latter (which is in the British Museum collection) seemed to agree with Perrier's redescription of the type of *ocellifera*. In response to a request from me, Dr. G. Cherbonnier very kindly examined the type of *N. ocellifera* and compared it with the published photographs of the type of *macrobrachia*, sending me at the same time a drawing of tabula of the two species *N. ocellifera* and *ocellata* which perfectly justifies Perrier's assertion that two species were included by Lamarck under the name *Asterias ocellifera*. Dr. Cherbonnier agreed with me in thinking that the granule covering of the tabula in *ocellifera* appears very similar to that of *macrobrachia*.

However, following correspondence with Dr. R. W. George of the Western Australian Museum, Perth, I was lent eleven specimens of *Nectria* by him and three further ones by Dr. E. P. Hodgkin of the University of Western Australia. My thanks go to both of them for their help. Among the first eleven specimens were three of *N. ocellifera* two of which (from between Fremantle and Geraldton) had been seen also by H. L. Clark. These show that although there is a superficial resemblance between the granule coverings of the tabula in *N. ocellifera* and *macrobrachia*, the tabulum of each proximal plate is several times higher in *ocellifera*, the column being hour-glass shaped, as Perrier described it, while the height is usually about 3 mm. Also each tabulum is widely separated from its neighbours and the granules covering the central part of its apex are very low, while the marginal ones are flattened and resemble the petals of a daisy. The proximal tabula of *N. macrobrachia* when denuded are seen to be very low, only about 1 mm. high and hardly, if at all, higher than the distal ones, all the tabula having vertical sides; also the low columns of neighbouring tabula are often in direct contact with each other or else are linked by short bridges sunk only a little below the level of their upper surfaces (text-fig. 2G). Consequently the peripheral granules of neighbouring tabula are always very close.

The granules of the proximal plates of the two species are also rather different when examined under magnification. Taking specimens with R about 60 mm., the central granules of *ocellifera* are very low, almost discoidal, their height only about 0·1 mm., that is less than a quarter of their diameter, which is usually between 0·5 and 0·75 mm.; they are slightly spaced and tapered towards the top, which, together with their squat form, makes them appear to merge into the underlying tabulum. These granules in the Port Phillip specimen of *N. macrobrachia*, on the other hand, are still not as high as wide but their height is about 0·25 mm. while the diameter is usually about 0·4 mm., a ratio of nearly two-thirds; in dorsal view they appear similarly polygonal but much closer together,

since each granule is capitate and widest at the top, consequently they appear to stand out sharply from the surface of the plate. The peripheral granules of *N. ocellifera* are distinguished from the central ones much more sharply than are those of *macrobrachia*. They are all more or less flattened in such a way that in the radial plane (relative to the centre of the tabulum) they are wedge-shaped in the outer half (text-fig. 2c) and their total size is greater, the length of many of them exceeding 1 mm. Most peripheral granules of *N. macrobrachia* also tend to be wedge-shaped outwardly, but they are shorter and relatively thicker, so that when seen from above their thickness in the radial plane is not much less than that in the tangential plane.

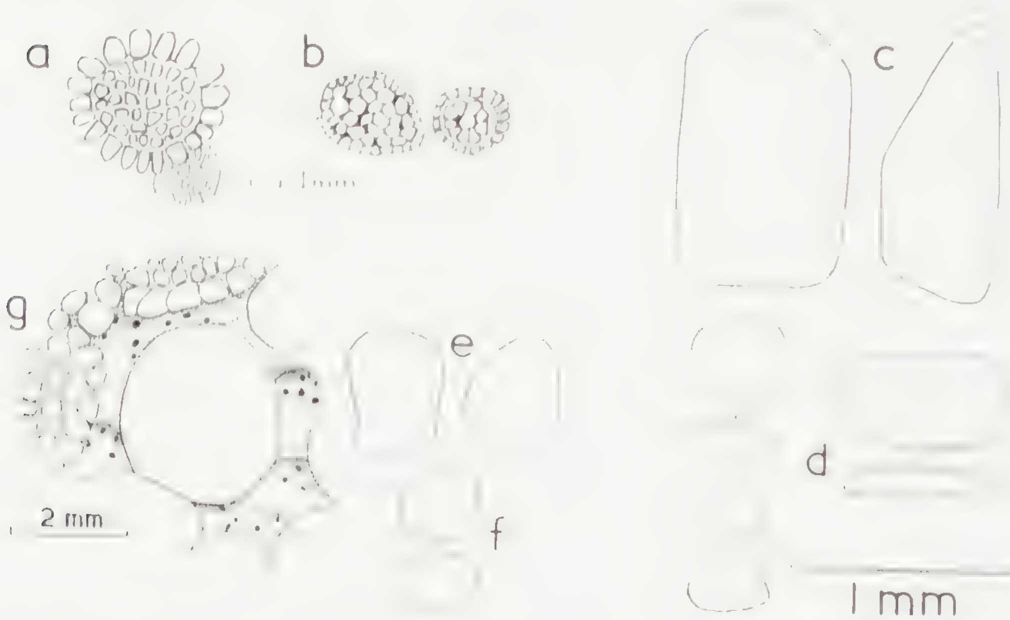

FIG. 2. *Nectria* spp.: **a** tabulum and madreporite of the type of *N. ocellifera*, **b** two tabula of the type of *N. ocellata* (both drawn by Dr. G. Cherbonnier), **c** a peripheral tabular granule of *N. ocellifera*, W. Australian Museum No. 3·62, in radial (left) and tangential (right) views, **d** three central tabular granules of the same specimen viewed from above (upper- and the side (lower), **e** peripheral and **f** a central tabular granule of *N. macrobrachia*, B. M. No. 1958 7.30.19, Port Phillip, as for **c** and **d**, **g** *N. macrobrachia*, detail of a denuded tabulum showing the close approximation of adjacent ones, with one column even in direct contact with another. (The large 1 mm. scale applies to **c–f**).

Along each arm at about half R from the centre, in all the species of *Nectria* except *N. macrobrachia*, there is a sudden transition in the form of the tabula. The distal ones are much lower than the columnar proximal tabula and usually distinctly convex at the top. In all three specimens of *N. ocellifera* that I have seen, the distal tabula have the peripheral granules abruptly *smaller* than the central granules which are enlarged in comparison with the central granules of the proximal tabula. This is just what is found on both the proximal *and* the distal tabula of *N. multispina*—the peripheral granules are the smallest, the whole surface is convex and the central granules are enlarged and closely crowded together. In most

specimens of *N. ocellata* the peripheral granules of the distal plates are not conspicuously smaller than the central ones and the surface of each tabulum is more or less flat, so that the limits between the plates are less obvious than in *N. multispina* and *ocellifera*.

In *N. macrobrachia* the distal plates have low, flat tabula like the proximal ones and their peripheral granules are reduced in size relative to those of the proximal tabula, but not to such an extent that they are smaller than the central granules. The resulting approximate uniformity in granule size obscures the limits of these plates which are only discernable by the positions of the papulae in the interstices between them.

The Cape Schank specimens of *N. macrobrachia* all have the abactinal granules rather coarser than in the three other specimens studied—namely the one from Port Phillip, the holotype and another specimen from Western Australia (4 miles off Dunsborough, Geographe Bay south from Fremantle) lent to me by Dr. Hodgkin. In a Cape Schank specimen with R 50 mm. one of the largest proximal tabula has its greatest diameter (including the spread of the peripheral granules) 3·5 mm. and there are 30 central granules and 25 peripheral ones. The Port Phillip specimen with R 45 mm. has the largest tabula over 4 mm. in diameter, some of them with more than 50 central granules but only 18 to 24 peripheral ones. Two out of five specimens collected in 1963 off Port Phillip Heads in areas 58 and 66 have the peripheral granules of the proximal tabula much larger, more angular and more outstanding than in the specimen photographed.

These Victorian specimens therefore extend our knowledge of the range of variation of the species as well as its geographical range. Previously the only record was the type locality, Houtman's Abrolhos, Western Australia.

Nectria ocellata Perrier.

Pl. II., figs. 3, 4.

Asterias ocellifera (part) Lamarck, 1816, p. 553.

Nectria oculifera (lapsus for *ocellifera*) Gray, 1840, p. 287.

Nectria ocellifera Gray, 1866, p. 15; Sladen, 1889, pp. 319–321, pl. 55, figs. 1–7.

Nectria ocellata Perrier, 1875, pp. 188–190; H. L. Clark, 1916, pp. 34–35; 1928, p. 378; 1938, p. 78; 1946, p. 85.

MATERIAL.—Port Phillip Survey: Area 59 (24), 1 specimen. Portland, Victoria, J. Wilson, 1 specimen.

REMARKS.—The two specimens have R respectively 56 and 70 mm. They were only collected in 1963 after this report had been completed and so are not included in Table 3. However, both are worthy of comment with regard to the distribution of the pedicellariae, since the one from Portsea Pier [Area 59 (24)] has some marginal pedicellariae while the Portland specimen has a few actinal ones, unlike any of the examples of *N. ocellata* included in the table. Both specimens have rounded proximal tabula, well spaced in the preserved condition.

Nectria multispina H. L. Clark.

Pl. II, figs. 1, 2.

Nectria multispina H. L. Clark, 1928, pp. 375–378, fig. 111; 1938, p. 77; Cotton and Godfrey, 1942, p. 197; H. L. Clark, 1946, p. 86.

? *Nectria* sp. possibly new, Fisher, 1911. Bull. U.S. Nat. Mus. 76, pp. 163–164.

MATERIAL.—Port Phillip Survey: Areas 58 (150–4), 1 specimen; 59 (24); 66 (—), 2 specimens; Cape Schank, 2 specimens; Port Phillip Heads, British Museum collection J. B. Wilson, 1 specimen.

REMARKS:—The specimen from Lonsdale Bight is large with R/r 102/37 mm. It is very like the photographs of the holotype. The specimens from Cape Schank have R/r 75/26 mm. and 82/28 mm. They differ from the type in having the larger proximal tabula markedly convex with the polygonal granules, except for the peripheral ones, quite smooth on top and so expanded and closely welded together that their limits are indistinct if not lost altogether on the most convex plates. Both specimens have usually four or five furrow spines, occasionally three on odd plates; the numbers seem to be distributed at random along the furrow and there is no regular diminution in number distally. These specimens have a number of pedicellariae, usually with three wide, blunt valves coarser than the adjacent granules on the proximal actinal plates bordering the adambulacrals, as in the holotype. There are also a few pedicellariae, mostly bivalved, on some of the interradial infero-marginal plates, especially near their upper edges, besides the usual adambulacral pedicellariae. The abactinal tabula are so crowded together that it is not possible to see whether there are pedicellariae also on their sides below the crowns of granules. Such pedicellariae were described in the type specimen of *Nectria pedicelligera* Mortensen, from New Zealand which also had some on the marginal and actinal as well as on the adambulacral plates. The valves of all these pedicellariae of *N. pedicelligera* were spiniform and more slender than the adjacent granules, besides numbering four to six rather than two or three, sometimes four, as in these specimens of *multispina*. However, two specimens from Rottnest Island, Western Australia, lent to me by Dr. Hodgkin, have actinal pedicellariae with relatively narrow valves, so the coarseness of the pedicellariae is probably not a distinguishing character.

Table 3 includes data derived from a number of specimens of *Nectria ocellata* mostly from the British Museum collection, unfortunately some of them without any locality and others simply labelled 'Tasmania' or 'Western Australia'. Also included are details of the holotype of *N. pedicelligera* Mortensen from New Zealand and of these Victorian specimens as well as of the holotype of *N. multispina* and a number of specimens lent to me by Dr. R. W George of the Western Australian Museum, and Dr. E. P. Hodgkin of the University of Western Australia.

The specimen from B.A.N.Z.A.R.E. station 113 off Maria Island, Tasmania, in 122 metres is unusual in having very short arms, R/r being only 2·3/1, whereas ten undoubted specimens of *N. ocellata* with R more than 30 mm. have the ratio varying from 2·5 to 3·25/1, averaging 2·9/1 (the specimen with the minimum value having the disc unnaturally flattened giving an abnormal r measurement). Unfortunately the only

TABLE 3.

B.M. Registered Number or Designation	Locality	R (mm.)	r (mm.)	Marginal Plates	Tabular Outline (R Round, A Angular)	Tabular Granules: Central	Tabular Granules: Peripheral	Furrow Spines	Pedicellariae: Tabular	Pedicellariae: Adambulacral	Pedicellariae: Actinal	Pedicellariae: Marginal
90.5.7.442	Bass Strait	20	9	14	R (A)	1	2	(4) 3	—			—
90.5.7.443	Bass Strait	23	9.5	14	R (A)	1	2	(4) 3				
	"	35	13	27, 28	R A	2	1, 2	3 (2)				
90.5.7.444	Bass Strait	47	18	27, 28	R	2	3	2 (3)		(+)		
62.7.9.52	Dirk Hartog I.	48	16	25	R–A	2	2	3 (2)	+			
1953.4.27.24	"	50	15	26	R	1	1, 2	(4) 3	(+)	(+)	—	—
BANZARE st. 113	Tasmania	50	22	20	R	1	3	4, 3				
W.A.M. 6.62	Gt. Aust. Bight	65	20	23	R	2	2	5–3				
1953.4.27.23 (pt.)	Tasmania	65	23	28	R A	1	1	3	—	(+)	—	—
1953.4.27.23 (pt.)	Tasmania	65	21	31	R A	1	1	3		(+)	—	
62.7.9.51	Western Australia	68	24	27, 28	R	1	1	(4) 3	(+)			
1958.7.30.20	Tasmania	70	27	26	R	1	1	3		(+)	—	
62.1.8.18	Tasmania	80	32	24	R	1	1	(4) 3	(+)			
W.A.M. 18.59	C. Naturaliste	62	20	25, 26	R	1	0	3 (2)	—			
W.A.M. 19.59	Dunsborough	80	25	26, 27	R	1	0	3		(+)	—	—
W.A.M. 2.62	Leeuwin	90	30	26	R	1	0	(4) 3	—			
62.1.8.10	Tasmania	48	15	25	R–A	2	2	4		+	+	—
62.1.8.11	Tasmania	50	18	23, 24	(R) A	3	3	(5) 4 (3)	+			
N. pedicelligera T.	New Zealand	53	19	26, 27	A–R	2	3	3		—	(+)	(+)
46.8.3.14	Tasmania	57	18	26	R (A)	2	3	3, 4	+	(+)	—	
W.A.M. 5.62	Albany	18	7	14, 15	A	3	3	3	(+)			
W.A.M. 4.62	Recherche Arch.	58	18	25, 26	(R) A	3	3	4	(+)		(+)	—
85.11.19.40	Port Phillip	65	17	31	R–A	2	3	3	—		—	+
W.A.M. 1.62	Albany	66	18	24	A	3	3	3	—		—	—
1962.4.9.7 (pt.)	Cape Schank	75	26	30–32	A	3	3	3–5	+			
Dr. Hodgkin's	Rottnest I.	77	22	24	A	3	3	(4) 3	+		—	
Dr. Hodgkin's	Rottnest I.	77	22	c.27, 28	A	(2) 3	3	2–4 (1)	+		(+)	
1962.4.9.7	Cape Schank	82	28	36	A	3	3	3–5	+			—
N. multispina T.	South Australia	80–85	30–32	32, 33	A	2	3	(6) 5 (4)		—	—	

Details of some specimens of *Nectria*; top—13 specimens of *N. ocellata*, next—3 Western Australian specimens affiliated to *ocellata*, next four specimens including the holotype of *N. pedicelligera* all intermediate between *ocellata* and *multispina*, finally 9 specimens including the holotype of *N. multispina*. In the first column, "W.A.M." signifies a specimen belonging to the Western Australian Museum. In the "Tabular Outline" column, "R (A)" signifies that a few tabula are slightly angular, but most are rounded, while "A (R)" is the opposite; "R–A" signifies an intermediate condition, the general impression being if anything rounded, while "A–R" suggests something a little more angular. The numbers under "Tabular Granules" show gradation of shape and crowding: for central granules 1 is slightly spaced, 2 close and angular, 3 tightly pressed together; for peripheral ones, 0 signifies longer, 1 similar, 2 slightly smaller and 3 distinctly smaller than the central granules. Furrow spine numbers on the left are limited to the proximal plates and on the right to distal ones, while mixing of numbers is shown by reversal of the magnitude with a hyphen (e.g., "3–5"). Brackets round positive pedicellaria records as well as furrow spine numbers signify rarity.

depth available for any of these ten specimens is 69–73 metres for the 'Challenger' one from Bass Strait which has R/r 2·6/1; it can only be presumed that most of the others were obtained by shore collecting or were from shallow water, since all were taken at least a hundred years ago. It is premature to suggest that there may be a short-armed form of *N. ocellata* from deeper water on the basis of this one specimen.

The variable characters covered in Table 3 include the apparent angularity or roundness of the proximal abactinal tabula, the relative size of their peripheral granules (similar to or smaller than the central granules), the spacing or crowding of the central granules, the number of marginal plates relative to size, the number of furrow spines and the occurrence and distribution of pedicellariae. The first character may be affected by the state of preservation of the specimen, resulting in a varying degree of contraction of the granule covering, but this is also influenced by the degree of crowding of the granules of the tabula. If these are expanded on their upper surfaces and fit closely together when the specimen is preserved, then, in life, they could not have contracted further and the outline of the whole tabulum must have been the same shape as now. The 'Challenger' specimens of *N. ocellata* (named *N. ocellifera* by Sladen) are particularly well-preserved so that the skin is not at all shrunken but envelops and softens the outlines of the tabula making their columns appear cylindrical rather than hour-glass-shaped; when the skin has been dissolved away, each tabulum is seen to be constricted below the crown as in most dry specimens of *ocellata*.

As Sladen pointed out, the smaller 'Challenger' specimens are interesting in the numerous pedicellariae they show at the edges of the flat surfaces of the tabula, taking the place of some peripheral granules. In most larger specimens of *N. ocellata*, as in the holotype of *N. pedicelligera*, the pedicellariae have shifted their relative position over the edge so that they lie just below the granule-crown.

H. L. Clark distinguished *N. multispina* from the other species of *Nectria* 'in the characters of the dorsal tabulae, in the adambulacral armature and oral plates and in the pedicellariae'. The present material shows that the great number of furrow spines in the holotype of *N. multispina* (six proximally) is exceptional, since I have seen no specimens with more than five furrow spines, even though some of these specimens are more divergent than the holotype in the shape and armament of the tabula compared with the usual condition in *N. ocellata*. Also one of Dr. Hodgkin's fine specimens of *multispina* from Rottnest Island off Fremantle has only a single very wide furrow spine on odd plates here and there, the other plates having two to four spines. The occurrence of pedicellariae is clearly variable, though they are more frequent in *N. multispina* and actinal ones were found only in one (see p. 311) of the 'typical' specimens of *ocellata* (as opposed to the intermediate specimens distinguished in the table).

Mortensen distinguished *N. pedicelligera* from *ocellifera* and *ocellata* by its tabula of differing shape, size and arrangement, its more numerous (26–27) marginal plates and its many pedicellariae. His knowledge of the two latter species appears to have been confused by Sladen's identification of the 'Challenger' specimens of *N. ocellata* as *ocellifera*, which made Mortensen doubt the validity of *ocellata*.

It is clear from the table that the number of marginal plates in *N. pedicelligera* is not distinctive. As for the tabula, I include here a photograph (Pl. II, fig. 4) of one of the intermediate specimens from the British Museum collection (No. 62.1.8.10, Tasmania) for comparison with Mortensen's photographs of the type of *N. pedicelligera*. Possibly the Tasmanian specimen should be considered as conspecific with the type of *multispina*. In that case there would be no alternative but to refer *multispina* to the synonymy of *N. pediceliigera*. Until we know more about the range of variation of the *Nectria* of New Zealand waters, such a move is premature.

Included in table 3 are details of three specimens from the Cape Naturaliste–Cape Leeuwin peninsula, south-west Australia, lent to me by Dr. R. W. George (one of them illustrated on pl. I, figs. 4–6). These are labelled '*Nectria* cf. *ocellifera*' but I am inclined to refer than rather to *N. ocellata*. Although the peripheral granules of their proximal tabula are higher than the central ones and some of them are slightly flattened, there is nothing like the difference between peripheral and central granules that is so conspicuous a feature of the three specimens of *N. ocellifera* from the collections of the Western Australian Museum. The peripheral granules in the three doubtful specimens are not at all splayed out, also they are only slightly higher and their thickness is hardly, if at all, greater than that of the central granules, which are rounded in outline and convex above, though similarly spaced to those of *N. ocellifera*. Also all the tabular granules are distinctly coarser than those of *ocellifera* and those of the distal plates are not clustered into well-defined convex groups corresponding to the underlying plates. The coarseness of the granules also distinguishes them from the specimens of *N. ocellata* in the British Museum collection as well as the example of *ocellata* from the Great Australian Bight borrowed from the Western Australian Museum. Instead of having more than twenty central granules and a similar number of peripheral ones on the larger tabula, as is usual in *ocellata*, these have only five to ten central granules and ten to fifteen peripheral ones, rarely more. At about three-eighths R from the centre there is often only a single central granule on each tabulum and distal to this, whether the tabula are low, the one or more central granules of each plate are distinctly enlarged and outstanding, though the peripheral granules of adjacent plates tend to become almost contiguous, obscuring the outlines of the individual plates. In specimens of *N. ocellata* from the vicinity of Tasmania, the granules of the distal plates may appear in convex groups or flat and almost continuous but usually one or more central granules are distinctly wider, if not higher than the rest, at least at the tip of the arm. In *N. multispina* the arrangement in convex groups with several enlarged central granules seems to be the normal condition.

It is possible that *Chaetaster munitus* Möbius, 1859, is conspecific with *Nectria multispina*. Sladen, 1889, thought that it is a synonym of *N. ocellifera* (i.e., of *ocellata* since Sladen confused the two), but the tabula of *munitus* appear to be rather angular in Möbius' figure, more like those of *multispina*. The holotype of *C. munitus* was in the Kiel or the Hamburg museum and came from an unknown locality; the species does not appear to have been recorded since so that the name could be regardec as a nomen oblitum.

Petricia vernicina (Lamarck).

Asterias vernicina Lamarck, 1816, p. 554.

Petricia punctata Gray, 1847, p. 80; 1866, p. 16, pl. 6, fig. 1.

Petricia vernicina: H. L. Clark, 1928, p. 388; Cotton and Godfrey, 1942, p. 200; H. L. Clark, 1946, p. 110.

?*Petricia obesa* H. L. Clark, 1923, pp. 241–243, pl. 13, figs. 1, 2; 1938, pp. 142–143, pl. 10, fig. 1; 1946, p. 110.

MATERIAL.—Port Phillip Survey: Areas 6, (65, 137), 2 specimens; 26 (41), 1 specimen; 15, (53), 1 specimen; 24, (Mordialloc) 4 specimens. J. B. Wilson: Port Phillip Heads, 1 specimen. Also two specimens from Merricks, Westernport, Victoria, 29.10.61.

REMARKS.—Out of the eleven specimens recorded above, all but two have the arms tapering evenly. The other two—one from Williamstown and the other from Port Phillip Heads—have the arms finger-like, not diminishing significantly in width distally and ending in a broad, rounded tip, just as in the holotype of *P. obesa* H. L. Clark from the Abrolhos, Western Australia. H. L. Clark distinguished his species from *vernicina* of south-east Australia, not only by the broad-tipped arms, but also by the absence of " tubercles, spinelets on even granules " on the distal marginal plates and the thick skin which is " not at all smooth and shiny when dry ".

Beside the Victorian specimens, all of which are in spirit, I have examined ten dry specimens of *P. vernicina* from localities ranging between Tasmania and Moreton Bay, Queensland. Not one of these has any trace of tubercles or other projections on the distal marginal plates and I can only think that H. L. Clark was labouring under a misapprehension when he said that such projections were characteristic of Lamarck's species. I must admit that all the dry specimens in the British Museum collection have the skin semi-transparent, revealing the positions of the underlying plates, though it is not particularly shiny. Possibly the dry holotype of *P. obesa* had previously been soaked in formalin or corrosive sublimate, which might account for its different appearance.

H. L. Clark (1938) recorded three other specimens of *P. obesa* from localities in Western Australia, but commented only on their size and colour, making no mention of the shape of their arms. It remains to be seen from further specimens from the west coast, whether or not the arms are consistently finger-like.

Austrofromia polypora (H. L. Clark).

Pl. III, fig. 1.

Fromia polypora: H. L. Clark, 1916, pp. 51–53, pl. 14, figs. 1, 2.

Austrofromia polypora: H. L. Clark, 1921, pp. 48–49; 1928, pp. 387–388; 1938, p.132; 1946, p. 114.

MATERIAL.—Port Phillip Survey: Area 66 (292) 1 specimen; J. B. Wilson, British Museum collection, 3 specimens, Port Phillip Heads.

REMARKS.—Wilson's specimens were named *Patiria crassa* by Bell. That Western Australian species has since been referred to *Parasterina*, which is distinguished by having large rounded primary abactinal plates surrounded by many small secondary ones, whereas in the Port Phillip examples all the plates are of similar small size.

One Wilson specimen is regenerating the tips of two arms, but in all three, the intact arms are more nearly cylindrical and blunter at the tip than in the photograph of the holotype of *polypora* or in three specimens from the type locality (off Maria Island, Tasmania) collected by the B.A.N.Z.A.R. Expedition at station 113, all of which have the arms slightly wider at the base and tapering to a fairly acute tip. H. L. Clark gave the width at the arm tip in the large holotype (R 86 mm.) as 4 mm., but this measurement must have been slightly inset from the extremity. In the best preserved Port Phillip specimen R/r is 65 mm./14 mm., br at the base is also 14 mm. and at 2 mm. from the tip is about 6 mm. In a B.A.N.Z.A.R.E. specimen with R/r 65mm./16mm., br at the same distance from the tip is less than 5 mm.

H. L. Clark himself (1916) comments that a specimen from Westernport, Victoria with R/r 65 mm./16 mm. appears stouter than the type; he also notes that "the granulation and adambulacral armature are noticeably coarser and the papulae, especially on the actinal surface, seem large". There does not appear to be any appreciable difference in the size of the papulae or the coarseness of the granulation in the Port Phillip specimens as compared with the B.A.N.Z.A.R.E. ones, but the number of furrow spines is rarely more than two in two of the Wilson specimen and only basally three in the third. Also the adambulacral plates when denuded are seen to be much shorter in these specimens than in the Tasmanian ones, where they are almost square. At the same time the number of adambulacral plates corresponding to the neighbouring actinal plates is greater. In a Tasmanian specimen partially denuded, the actinal plates correspond exactly in position and number to the adambulacral ones, for the first half of the arm at least, while in the Port Phillip specimens there are about 26 actinal plates corresponding to 30 adambulacrals. Another difference is in the size and regularity of the marginal plates. In the Port Phillip specimens these are particularly irregular and inconspicuous, forming two ill-matched series along the side of each arm, whereas in the Tasmanian examples the series can easily be followed through and for much of the arm length two abactinal plates above or two actinal ones below correspond to each plate of the two marginal series.

Some comparitive remarks about *Austrofromia polypora* are also given under the heading of *Nepanthia hadracantha.*

I am doubtfully referring to this species a specimen from area 66 off Port Phillip Heads collected in 1963. It has R/r 27–28 mm./8·5 mm. and so its arms are only half as long as those of the smallest specimens of *A. polypora* known to me. The marginal plates number about fifteen in each series in comparison with about 30 rather irregular ones in a Wilson specimen from Port Phillip Heads with R about 55 mm. In the smaller specimen the marginals are quite prominent, making up the whole side wall of the body, since there is considerable dorso-ventral flattening in comparison with larger specimens of *Austrofromia.* The dorsal plates are relatively few in number and large and some of them are convex so that the general appearance approaches that of some tropical Indo-Pacific species of the related genus *Fromia.* The single papular pores extend to the innermost row of actinal plates and there are three furrow spines proximally, giving way to two distally.

Patiriella gunni (Gray).

Asterina gunnii Gray, 1840, pp. 289–290; 1866, p. 16; Perrier, 1875, pp. 298–299; McCoy, 1890, p. 372, pl. 200, fig. 2.

Patiriella gunnii: H. L. Clark, 1928, pp. 392–393; 1938, pp. 165–166; 1946, p. 135.

MATERIAL.—Port Phillip Survey: Areas 14 (5), 26 (126, 300), 3 specimens; 27 (41); 30 (10); 39 (43, 47) 6 specimens; 42 (38) 2 specimens; 50 (229–30) 4 specimens; 58 (81, 150–4) 4 specimens; 59 (24) 8 specimens; J. B. Wilson Port Phillip Heads, 8 specimens.

REMARKS.—At least one of the specimens, from Corio Bay Area 26, was dull purple dorsally when received, being still preserved in formalin. This is the colour supposed by H. L. Clark to be characteristic for his species *P. brevispina*. Colour notes were not supplied with the remaining specimens but it is possible that a proportion of them were also this colour since McCoy noted the colour of his Victorian specimens as generally purple rather than the variegated greens and browns usual for *P. gunni*.

The type locality of *P. brevispina* is Bunbury, south-west Australia. H. L. Clark distinguished it by the shorter, flatter and more truncate actinal spines, in comparison with those of *P. gunni*. However, he did comment that there is considerable doubt whether *brevispina* should be considered only as a colour variety of *gunni*. After an examination of twenty of Gray's specimens all collected by Gunn at George Town, Tasmania (and presumably the types though not designated as such) I too am doubtful whether *brevispina* can be distinguished morphologically from *gunni*. Although after 125 years in the dried state there is not a trace of colour on Gunn's specimens they are remarkably variable with regard to the relative size of the actinal spines. Ten of them have R between 20 and 28 mm. and the length of their actinal spines from about the middle of the interradii ranges from 0·45 mm. to 1·05 mm. The shape is always slightly but not markedly flattened, the minimum (dorso-ventral) thickness half-way along their length being generally 0·75–0·80 of the maximum (lateral) thickness at the same place. In about five of the twenty specimens the width of these spines is the same at the tip as at the base, usually with a " waist " in between but in the others the spines are slightly tapering towards the tip. The subambulacral spines also vary somewhat in shape, five specimens having them distinctly broadened and flattened at the tip. However, no correlation was found between flattening of the subambulacral spines and shortness of the actinal ones.

It remains to be seen from examination of specimens retaining their natural colour whether or not there is any correlation between that and the proportions of the spines.

Nepanthia hadracantha sp. nov.

Pl. III, figs. 4–6, Text. fig. 3 a, b.

Parasterina sp. cf *troughtoni*: A. M. Clark, 1956, pp. 378–380, text. fig. 3, pl. 11.

MATERIAL.—Port Phillip Survey: Area 66 (292), 2 specimens; Cape Schank, 9–12 metres, rock bottom, 4 specimens (Holotype National Museum No. H. 14); Port Phillip, British Museum Collection (1 specimen probably collected J. B. Wilson at or near the Heads).

REMARKS.—The specimen from " Port Phillip " was described and figured in 1956. The Cape Schank specimens, including the holotype, differ from it mainly in the narrower arms and the smaller and more

irregular abactinal plates. (Though foreshortening in the photograph of the abactinal view given in 1956 has exaggerated the relative breadth of the arms in the Port Phillip specimen.)

DESCRIPTION of the Holotype.—R/r is 55 mm./12 mm. = 4·4/1; br at the base of the arm is 12–14 mm. and at 2/3R from the centre of the disc is 9·5 mm.

The arms are somewhat flattened, particularly on the under-side where the surface from the marginal plates to the furrow is slightly sunken in the preserved specimen (though probably more nearly flat in life). The abactinal plates extend on to the ventral side. The arms taper from the base, but a little more quickly in their outer halves; the tips are blunt and rounded.

The triangular madreporite is inconspicuous and lies in one interradius between 4 and 5 mm. from the centre.

The abactinal plates are all similar in size, the largest of them having a maximum diameter (with the spinelets intact) of just 2·0 mm. though the majority are about 0·8 mm. in their greatest width. There are two "fields" of plates; a dorsal one where the order is irregular, though in some parts an arrangement in diagonal rows can be discerned and a lateral field where the arrangement is in regular longitudinal rows; the shape of the plates in the dorsal field is variable, but in the lateral field the shape is regularly oval or rhombic. At the base of the arm, the dorsal field is only about 4 mm. wide but it broadens distally to encompass the whole arm width.

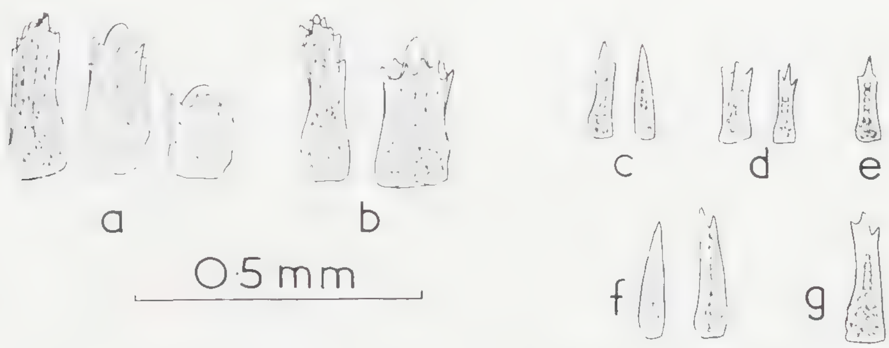

FIG. 3. Abactinal spinelets of *Nepanthia* spp.: **a** *N. hadracantha* holotype, R = 55 mm., **b** *N. hadracantha*, Port Phillip specimen, R = 53 mm., **c** *N. maculata* holotype, R = 39 mm., **d** *N. belcheri*, B. M. No. 1953.5.18.11, Moreton Bay, Queensland, R = 28 mm., **e** *N. brevis* holotype, R = 25 mm., **f** *N. variabilis* paratype, R = 35 mm. and **g** *N. briareus* syntype, R = 23 mm.

Most of the larger abactinal plates have 25–30 peripheral spinelets surrounding 35–40 others. On the disc the spinelet-covering of adjacent plates tends to be confluent. The spinelets are from 1·6 to 3·0 times as long as their maximum (basal) width, according to position, the peripheral ones being the longer and measuring about 0·3 mm. in length. Many of the spinelets have a distinct enlarged conical or blunted process in the middle of the free end between the terminal spinules.

When the spinelets are removed, most of the plates of the dorsal field are revealed as crescentic or triangular in shape with a large papular pore proximal (or adradial) to them in the hollow of the crescent or the middle of the hypoteneuse. The lateral plates are mostly triangular or quadrangular, but some have a concave side facing the corresponding pore.

The lateral plates extend on to the ventral surface for at least a quarter of the arm breadth at most points.

The inconspicuous elongated marginal plates are smaller than the adjacent abactinal plates and form two irregular longitudinal rows on each side in the distal half of the arm; proximally they are not distinct from the actinal plates of which there are three longitudinal series, the outermost very short and the second only reaching for about half the arm length. The plates of the inner series are larger and more nearly regular than the others; they are slightly more numerous than the marginal plates. There are no papular pores between the actinal and marginal plates or between the series of actinal plates.

The adambulacral plates when denuded have the shape of the sole of a foot, the heel directed laterally and bearing the subambulacral spinelets or spines. These number about ten and vary in arrangement from several rows parallel to the furrow to a semicircle around two or three other spinelets, or two rows at right angles to the furrow; they grade in size from the actinal spinelets to the furrow spines. The latter are similarly variable in arrangement, but usually there is an oblique or convex fan of four spines.

VARIATIONS.—The three other specimens from Cape Schank have R/r 55/12, 63/13·5, and 53/14 mm., while in the Port Phillip specimen it is 53/13 mm., a range from 3·8/1 to 4·7/1.

AFFINITIES.—The species probably most closely related to this one is *Parasterina troughtoni* Livingstone, 1934, with which I compared the Port Phillip specimen in 1956. At that time I commented that *troughtoni* is probably not congeneric with the type species of the genus, *Parasterina crassa* (Gray), which has rounded primary abactinal plates completely ringed by small, irregularly-placed secondary plates. In *Nepanthia*, if secondary plates are present at all, they lie in fairly regular positions with one to four of them proximal to the papular pore that lies in the hollow of each crescentic primary plate. Despite the similar finger-like outline of the arms of *troughtoni* and *P. crassa*, I believe that the former should be referred to the genus *Nepanthia*.

The type specimen of *N. troughtoni* came from King George's Sound, south-west Australia, while the type locality of *Parasterina occidentalis* H. L. Clark, 1938, which I consider is a synonym of *N. troughtoni* (1956, p. 380) is near Fremantle, Western Australia.

The holotype of *N. troughtoni* had R/r 16 mm./5·5 mm. or 2·9/1, while the type of *occidentalis* had the ratio 29 mm./7·5 mm. or 3·9/1. In both type specimens the arms are finger-like and not tapered at all and the abactinal plates appear large, rhombic and fairly regular. The spinelets of the type of *troughtoni* numbered about 40 to a plate and Livingstone described them as almost granule-like to the naked eye. So might the spinelets of *N. hadracantha* be described and the much larger size of the type specimen could account for their greater number. Nevertheless, the

fact that the Cape Schank specimens are less like the specimens of *troughtoni* so far described than is the Port Phillip specimen, particularly in the relative size of their abactinal plates, but are more like species such as *N. maculata*, together with the fact that all five Victorian specimens have tapering arms, prompts me to distinguish them as a new species. It remains to be seen whether or not *N. troughtoni* shares the peculiar form of the abactinal spinelets found in *hadracantha*. If it does, then the distinction between them may be less than a specific one.

In comparison with the other Australian species of *Nepanthia*, *N. hadracantha* comes closest to *N. tenuis* H. L. Clark from north-west Australia, though *tenuis* may itself be a synonym of *N. maculata* Gray, of which the type locality is the Philippines. The holotypes of all three nominal species have no secondary abactinal plates (though the "Challenger" specimen from Torres Strait identified as *maculata* by Sladen does have single secondary plates proximally). The arms of *N. maculata* are very slender, R/r in the holotype being 39 mm./7mm. or 5·6/1, while br proximally is 5·5–6·0 mm. In the type of *N. tenuis* R/r is 64 mm./11 mm. = 5·8/1 and br similarly approximately equals r. Both of these are therefore considerably more slender than the Victorian specimens, all five of which have R/r less than 5·0/1, while in one it is only 3·8/1. Another difference is in the size of the spinelets covering the plates. These are very much coarser in the Victorian species and terminate in multiple spinules, many of them having a very thick central process. The spinelets of *N. maculata* taper to a single point or have only two or three terminal spinules; in both the holotype and the "Challenger" specimen with R 67 mm. the spinelets are only about 0·18 mm. long. H. L. Clark's description of the abactinal spinelets of the type of *N. tenuis* as "minute, short and glassy" agrees with the form of those of *maculata*. The abactinal spinelets are correspondingly coarser and fewer in the new species than in either *maculata* or *tenuis*.

Of the remaining Australian species of the genus, *N. belcheri* (Perrier) from New South Wales, southern Queensland and Lord Howe Island, comes nearest geographically, but *belcheri* is usually multibrachiate (and even when five-armed has several madreporites) besides having several secondary plates corresponding to each primary abactinal one; *N. brevis* (Perrier) from northern Australia similarly has R/r about 4/1 but it too has one or more secondary plates; *N. magnispina* H. L. Clark, from north-west Australia differs in having very coarse, convex abactinal plates (secondary ones apparently lacking) and finally *N. variabilis* H. L. Clark, also from north-west Australia, has secondary plates and resembles a five-armed specimen of *belcheri* (but for the single madreporite). The abactinal spinelets were described only as "short, sharp and glassy" in *magnispina* but in the other species I found that they are relatively small with few terminal spinules (fig. 3).

Three further species of *Nepanthia* are known but have not been recorded from Australian waters. Of these, *N. suffarcinata* Sladen, 1888, from the Mergui Archipelago, Burma, differs in having several secondary plates corresponding to each primary abactinal one, *N. briareus* (Bell), from the South China Sea, is multibrachiate, though it does lack secondary plates (see A. M. Clark, 1956), and *N. joubini* Koehler, 1908, from Cochin China and the Philippines (Fisher, 1919), is both multibrachiate and has secondary plates.

There is a superficial resemblance between *Nepanthia hadracantha* and *Austrofromia polypora* (H. L. Clark), 1916, of which Wilson took three specimens at " Port Phillip ". The latter species is an aberrant temperate member of the Ophidiasteridae and does not run down easily to that mainly tropical family in H. L. Clark's keys of 1946 since the relatively poorly developed marginal plates are liable to lead one away from the old order Phanerozonia. Both species have rather similar proportions with single papulae between the slightly imbricating abactinal plates, which themselves are similar in size and superficially appear granulated. However, the papulae of *A. polypora* extend ventrally right up to the adambulacral plates, the abactinal plates are much more irregular in arrangement and their spinelets are much coarser and more nearly granuliform, besides being fewer in number correspondingly the adambulacral spines are fewer, with only two or three furrow spines on each plate.

Asterina atyphoida H. L. Clark

Asterina atyphoida: H. L. Clark, 1916, p. 57, pl. 17, figs. 1, 2; 1928, p. 389; Cotton and Godfrey, 1942, p. 201; H. L. Clark, 1946, p. 130.

MATERIAL.—British Museum collection, J. B. Wilson, Port Phillip Heads, 7 specimens.

These specimens were included with those named *Asterina gunni* by Bell. Since the species has never been properly described and the holotype was not very photogenic it seems worth while to give here some descriptive remarks. These are derived from a dried specimen from St. Vincent Gulf, South Australia, B.M. No. 1939. 6.15.91, named by H. L. Clark.

R/r is 9·5/8·5 mm., the specimen appearing perfectly pentagonal with the interradii straight.

The abactinal plates are in very regular series. There are five chevrons of rhombic ones in each interradius, while each radial area is occupied by five longitudinal series of rhombic, oval or oblong plates, most of which are very slightly indented proximally to accommodate the single papulae—these being restricted to the disc and the proximal two-thirds of each radial area. The five mid-radial series of plates each consist of eleven plates, but are stopped short of the terminal plates by the approximation of the distalmost three pairs of the adjacent adradial plates, the series of which each consist of thirteen plates.

The madreporite is small and triangular and lies close to the anus.

The surface of the abactinal plates has a granular texture, the convexities having a glassy appearance. Around the proximal edges of the plates are some minute conical spinelets, but these have mostly been rubbed off.

Along the margin is a short fringe of very fine spinelets, with two rows, each of about five spinelets, on each infero-marginal plate.

The actinal intermediate plates all have single spines which appear conical because of the sheath of skin which expands around the base of each one; a few of the distalmost plates have two spines.

There are about sixteen adambulacral plates in each series. Each plate has one large subambulacral spine and a furrow series of three webbed spines, except for the distalmost plates, which have two or even only one furrow spine.

The oral plates each have five (sometimes only four) furrow spines, the two innermost being the largest; on the ventral surface is a single suboral spine.

A spirit specimen from Port Phillip with R/r 11/10 mm. has the centre of the triangular madreporite only 2 mm. away from the anus. Its papulae are a little more distinct than in the dry specimen. Again they are limited to the disc and the radial areas. It is noticeable that they are absent between the plates of the mid-radial series, except for those on the disc, so that this row of plates appears to the naked eye as a slightly paler line. Some of the radial plates of this specimen could be termed crescentic in shape since they are distinctly notched proximally to accommodate a papula. More of the abactinal spinelets are intact in this specimen; the larger plates have 10–12 of them along their proximal edges.

This species is superficially very like *Patiriella exigua* (Lamarck), from which it differs in the much more conspicuous and regularly arranged abactinal plates, the smaller and distinctly triangular madreporite and the finer and exclusively peripherally-placed abactinal spinelets. A third pentagonal Asterinid from south-east Australia is *Asterina inopinata* Livingstone, but this has nearly all the abactinal plates much more markedly crescentic than *atyphoida*, also the furrow spines and actinal spines are more numerous.

OPHIUROIDEA.

KEY TO THE OPHIUROIDS OF THE EAST FLINDERSIAN REGION.

1. (8) Disc *and* arms covered with thick skin, concealing any underlying plates or scales when wet; arms branched or simple, cylindrical in cross-section.

2. (7) Arms branched.

3. (6) Arm spines present before the first fork .. .. .. *Astroconus*.

4. (5) Arms only annulated on the distal branches. *Astroconus australis* (Verrill), 1876.

5. (4) Arms annulated for their whole length. *Astroconus pulcher* H. L. Clark, 1938.

6. (3) Arm spines not developed before the fourth fork. *Astroboa ernae* Döderlein, 1911.

7. (2) Arms not branched. .. .. .. *Ophiomyxa australis* Lütken, 1869.

8. (1) Arms never and disc usually lacking opaque skin, disc often with spines, spinelets, thorny stumps or granules more or less obscuring the underlying scales, rarely skin; arms more or less flattened.

9. (12) Small species (disc diameter not known to exceed 6 mm.) with a large acute papilla at the apex of each jaw, the disc scaling obscured by spaced stumps and the arm spines large and projecting, the upper spines the longest, the lower ones rugose.

10. (11) Dorsal arm plates longer than wide and bell-shaped; oral shields with the distal side convex; only six arm spines proximally even when the disc diameter is 6 mm. .. *Ophiacantha brachygnatha* H. L. Clark, 1928.

11. (10) Dorsal arm plates wider than long and fan-shaped; oral shields (except the madreporite) with the distal side straight; seven arm spines on alternate proximal segments when the disc diameter is only 4 mm. .. .. *Ophiacantha alternata* sp. nov.

12. (9) Small or large; never a combination of a single *acute* apical papilla with spaced disc stumps obscuring the scales and projecting arm spines.

13. (28) A pair of large rounded or rectangular infra-dental papillae at the apex of each jaw. (Caution: a few other species, such as *Pectinura assimilis* and *Ophiozonella elevata*, may have the two innermost oral papillae infra-dental in position; they differ from the Amphiurids most obviously in having the arm spines appressed.)

14. (17) Two distal oral papillae on each side of each infra-dental pair.

15. (16) Outermost oral papillae twice as wide as the others, oral shields about as wide as long. .. .. .. *Amphipholis squamata* (D. Chiaje), 1828.

16. (15) Outermost oral papillae not distinctly larger than the others; oral shields much longer than wide. .. .. *Amphiodia ochroleuca* (Brock), 1888.

17. (14) Only one distal oral papilla each side, well spaced from the infra-dental ones.

18. (27) No spinelets on the disc, which is covered with scales or naked skin.

19. (26) One or two tentacle scales present on each pore.

20. (23) One tentacle scale.

21. (22) Radial shields narrow, about four times as long as wide; three arm spines on most segments, four or five only basally, when the disc diameter is 9 mm. *Amphiura trisacantha* H. L. Clark, 1928.

22. (21) Radial shields about three times as long as broad; six arm spines already when the disc diameter is only 5 mm. .. *Amphiura constricta* Lyman, 1879.

23. (20) Two tentacle scales.

24. (25) About seven spatular arm spines; disc covered with scales on both sides. *Amphiura poecila* H. L. Clark, 1915.

25. (24) Second from lowest of the five arm spines with a single hook proximally, giving way to a bihamulate form further out on the arm; disc scale-less ventrally adjacent to the oral shield. *Amphiura elandiformis* sp. nov.

26. (19) No tentacle scales. .. .. *Amphiura (Ophiopeltis) parviscutata* sp. nov.

27. (18) Spinelets present on the disc; these are sheathed in skin, which also tends to obscure the scales. .. .. *Ophiocentrus pilosus* (Lyman), 1879.

28. (13) Either a single oral papilla, several irregularly placed ones, or a cluster of tooth papillae at the apex of each jaw, never a regular pair on all the jaws.

29. (32) A single blunt papilla below the lowest tooth at each jaw apex, separated by a wide gap from one or two distal oral papillae arising from the adoral shields or the bases of the oral plates. .. .. .. *Ophiactis*.

30. (31) One large, fan-shaped distal oral papilla each side. *Ophiactis tricolor* H. L. Clark, 1928.

31. (30) Two small, squarish, distal oral papillae. .. *Ophiactis resiliens* Lyman, 1879.

32. (29) No division of papillae into an infra-dental one and widely separated distal ones, but either a cluster of tooth papillae below the lowest tooth, or a single papilla in series with similar oral papillae on each side, or both tooth papillae and contiguous series of oral papillae.

33. (38) An isolated cluster of tooth papillae at each apex; no oral papillae on the sides of the oral plates.

34. (35) Radial shields not very conspicuous, bearing small, rugose stumps similar to those on the rest of the disc; disc diameter rarely over 8 mm. *Ophiothrix caespitosa* Lyman, 1879.

35. (34) Radial shields conspicuous, quite bare in contrast to the rest of the disc; maximum size larger, disc diameter often over 10 mm.

36. (37) Dorsal arm plates rhombic, only narrowly in contact. † *Ophiothrix aristulata* (Lyman), 1879.

† I believe that the form of the dorsal arm plates allies *aristulata* more closey with *O. fragilis*, the type species of *Ophiothrix*, than with *P. melanosticta*, the type of *Placothiothrix*, to which latter genus *aristulata* was only provisionally referred by H. L. Clark; accordingly the species is here referred back to *Ophiothrix*.

37. (36) Dorsal arm plates flaring distally but successive ones very widely in contact. *Placothiothrix spongicola* (Stimpson), 1855.

38. (33) Oral papillae present as well as one or more apical papillae.

39. (44) A cluster of tooth papillae at each jaw apex.

40. (41) One tentacle scale. .. .. *Ophiocomina australis* H. L. Clark, 1928.

41. (40) Two tentacle scales.

42. (43) Arm spines plain coloured, not banded, a light longitudinal stripe on the underside of each arm. .. .. *Ophiocoma canaliculata* Lütken, 1869.

43. (42) Arm spines banded, ventral arm plates patterned. *Ophiocoma pulchra* H. L. Clark, 1928.

44. (39) Usually one and never more than two or three papillae at each jaw apex.

45. (48) Paired supplementary plates present on each arm segment lateral to each dorsal arm plate.

46. (47) Disc scales evident, not obscured by skin; maximum size large, disc diameter even exceeding 20 mm. .. .. *Ophionereis schayeri* (M. & Tr.), 1844.

47. (46) Disc scales and even the oral shields obscured by skin; not exceeding 10 mm. in disc diameter. .. .. *Ophionereis semoni* (Döderlein), 1896.

48. (45) No paired supplementary arm plates, though the dorsal plates may be fragmented irregularly (in *Ophioplocus*).

49. (56) Disc covered with granules, concealing the scales.

50. (51) Teeth wide and blunt, with hyaline edges; arm spines longer than the segments and standing out from them somewhat. *Ophiurodon opacum* H. L. Clark, 1928.

51. (50) Teeth narrow and more or less pointed, their edges not at all hyaline; arm spines short and appressed.

52. (55) Disc granulation concealing the radial shields.

53. (54) Supplementary oral shields (distal to the oral shields proper) small and narrow; maximum size large, disc diameter known to exceed 25 mm.; ten arm spines when the disc diameter is 23 mm. .. *Pectinura assimilis* (Bell), 1888a.*

54. (53) Supplementary oral shields about a third as long as the oral shield adjacent to them; not known to exceed a disc diameter of 12 mm.; ten arm spines already when the disc diameter is 10 mm. *Pectinura arenosa* (Lyman), 1879.*

55. (52) Radial shields left bare. .. .. *Ophiarachnella ramsayi* (Bell), 1888a.

56. (49) Disc not covered with granules, scales distinct.

57. (58) Dorsal arm plates fragmented. .. *Ophioplocus bispinosus* H. L. Clark, 1918.

58. (57) Dorsal arm plates entire.

59. (60) A large, convex, regular, triangular plate between the distal ends of each pair of radial shields and the base of the arm. *Ophiocrossota multispina* (Ljungman), 1867.

60. (59) No such plate present

61. (62) Two tentacle scales on most of the pores, each scale covering about half of the pore. .. .. .. *Ophiozonella elevata* (H. L. Clark), 1911.

62. (61) Six or more scales on the pores of the first segment, the number rapidly falling to one on the following segments as the pore size decreases.

63. (64) Dorsal arm plates wider than long, the successive ones broadly in contact. *Ophiura kinbergi* Ljungman, 1866.

64. (63) Dorsal arm plates longer than wide, barely in contact. *Ophiura ooplax* (H. L. Clark), 1911.

* It is not impossible that these will prove to represent only a single species of *Pectinura*, large specimens having been attributed to *P. assimilis* and smaller ones to *arenosa*. Only a good series of specimens will settle this.

Ophiacantha alternata sp. nov.

Text–fig. 4.

MATERIAL.—Port Phillip Survey: Areas 6 (137), 4 specimens; 15 (284), 1 specimen, 50 (233), 1 specimen; 58 (150–4), 15 specimens (Holotype National Museum No. H 15, Paratypes No. H.16); 59 (36), 17 specimens.

DESCRIPTION of the holotype.—The disc diameter is 3 mm. and the arm length 10 mm. The arms are attenuate, tapering proximally more than they do distally. They appear slightly moniliform, especially in oblique view where the flaring of the lateral arm plates is most obvious.

The dorsal side of the disc is covered with spaced stumps, most of them slightly higher than wide and cylindrical or tapering, ending in several points. Among these stumps in each interradius close to the edge of the disc are about five short, blunt, tapering spines; similar spines also occur sparsely near the centre of the disc. The scaling is obscured everywhere except at the junctions of arms and disc. The radial shields are also obscured except at their widely-spaced distal ends, where they articulate with the upper ends of the genital plates, the latter being just visible through the skin in lateral view. On the ventral side, the stumps extend right up to the oral shields and the scaling is completely obscured.

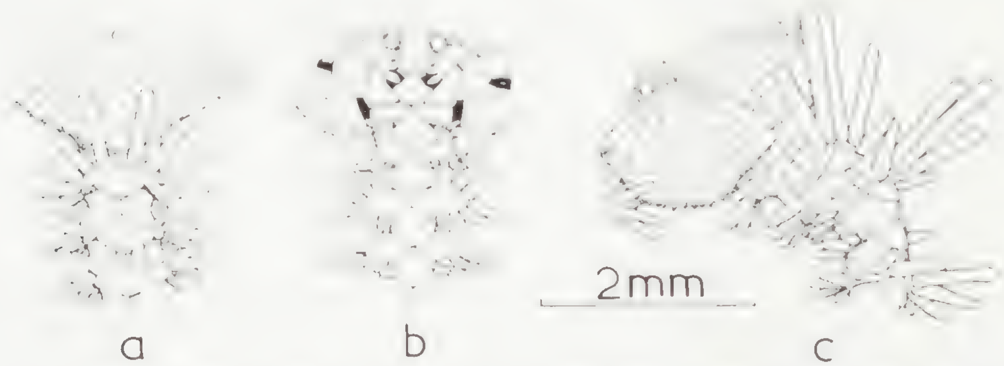

FIG. 4. *Ophiacantha alternata*: **a** and **b** holotype, part of disc and an arm base in **a** dorsal and **b** ventral views (the oral shield on the left being the madreporite), **c** paratype with disc diameter 4 mm., in oblique dorso-lateral view.

The oral shields are triangular, nearly twice as wide as long, with the proximal angle obtuse. The madreporite only is rhombic in shape with a distal angle. The adoral shields are large, meeting widely interradially and at their other ends separating widely the oral shield and the first lateral arm plate on each side.

There are three oral papillae each side, all of them borne on the oral plate. At the apex of the jaw is a single large, leaf-like papilla with an acute tip.

The ventral arm plates are at first fan-shaped, then become pentagonal by developing a slight angle at each of the small tentacle pores. All of them have the distal edge markedly convex. The consecutive proximal plates are just separated from each other (the third segment in the arm drawn has become displaced so that the gap is unnaturally widened) and the smaller distal plates are more widely separated.

The dorsal arm plates are all fan-shaped, though there may be a slight angle in the middle of the distal edge so that they could be described as rhombic. They are all much wider than long, the proximal ones having the length equal to about two-thirds of the breadth. All of them are widely separated.

The lateral arm plates are large, even the proximal ones meeting widely above, though narrowly below; they flare slightly towards their distal ends where each bears up to 7 spines. The first one or two free segments (i.e. the third and fourth), usually both of them, have seven spines on each side, the two series being almost continuous dorsally. The uppermost spines are the longest, measuring up to 0·8 mm. in length. The second spine is almost as long and like the top one is slightly clavate in shape, not tapering. The third spine is much shorter, measuring 0·4 mm. in length and, like the ones below it, tapers slightly to a very blunt tip. The middle spines are also distinctly rugose in contrast to the upper ones which are smooth. On three arms the third and fourth segments both have seven spines, as just described, the fourth arm (figured) has only the third segment with its full complement of spines and the fifth arm has only the fourth segment with the uppermost spines enlarged, though there are seven spines on the third each side. The following segment—the fifth on four arms and the fourth on the one drawn—has only five spines, the two uppermost of the series lacking, while the next segment again has seven spines, the next five, then seven, after which the numbers fall to four and six, with the regular alteration continuing.

The single tentacle scale is elongated and pointed.

The arm plates have their surfaces sculptured with concentric lines, particularly at the distal ends of the dorsal and ventral arm plates and around the proximal constricted part of each lateral plate.

In the centre of each oral shield there is a dark spot and in the hollow between each pair of oral plates a cluster of dark dots. Otherwise the colour in spirit is light brownish.

Another specimen from (Area 58), Lonsdale Bight is shown in partial lateral view in the figure; it has the disc diameter 4 mm. but its arms are all bent downwards sharply near their bases so that the ventral side is obscured. For this reason it was not selected as the holotype. It has more prominent interradial disc spines, which extend further towards the centre. The first two free arm segments have eight spines, the next one six, the next seven, then five and seven alternately. The uppermost spine of the eight is nearly 2 mm. long. Another specimen with the disc diameter 4 mm. has no more than seven spines, the uppermost about 1·3 mm. long, whereas the length of a proximal arm segment is about 0·4 mm., so that the longest spines are at least three times as long as the segment. Some of the other specimens have the disc spines arising not so much in the interradii as near the centre of the disc. The occurrence of the dark spots on the oral shields is not invariable; in some specimens they are very pale and in others absent altogether.

AFFINITIES.—At first I was inclined to refer these specimens to *Ophiacantha heterotyla* H. L. Clark, 1909, known from off New South Wales and Tasmania (H. L. Clark, 1938). Both have the disc covered with small stumps and some blunt spines (though in the type of *heterotyla* the spines are located only at the position of the inner ends of the radial

shields), in both species the distal ends of the radial shields are all that show, the dorsal arm plates are fan-shaped, the uppermost arm spines are the longest and there is a black spot on each oral shield (particularly well-marked in Tasmanian specimens of *O. heterotyla* where the proximal ventral arm plates are also spotted). However, there are a number of differences. The holotype of *O. heterotyla* similarly has a disc diameter of 3 mm. but it has fewer arm spines, only five on the first segments then four and these spines are tapering (at least in H. L. Clark's figure). Nor is there any mention in Dr. Clark's description of the alternation in the numbers of arm spines which is such a feature of these Port Phillip specimens. The oral shields of *O. heterotyla* are pentagonal rather than triangular and the adoral shields in the figure do not appear to separate the oral shield from the lateral arm plates. The ventral arm plates in *O. heterotyla* are pentagonal with the distal edge concave, in contrast to the markedly convex distal edge shown by the Port Phillip specimens. Finally, in the figure of *O. heterotyla* the outermost oral papilla is shown as arising from the adoral shield, whereas in the present species all three papillae are based on the oral plates, the outermost one being directed over the oral tentacle parallel to the edge of the adoral shield.

It may be noted here that *O. heterotyla* is very similar to the holotype of *O. vepratica* Lyman, 1878 (Bull. Mus. Comp. Zool. Harvard, 5, p. 137), which was from deep water (1097 metres) near the Kermadec Islands (north of New Zealand). Fell (1958, Zool. Publ. Victoria Univ. Wellington, No. 24, p. 25 and 1960, Bull. N. Z. Dept. S.I.R., 139, p. 67) has also recorded as *vepratica* two specimens from the Chatham Rise, to the south-east of New Zealand, in 476 and 549 metres, though these lacked spines among the disc stumps, like *O. sollicita* Koehler, 1922 (Austral. Ant. Exped., Sci. Rep., C8 [2]) from off Tasmania in 2377 metres.

Another related Australian species is *O. brachygnatha* H. L. Clark, 1928, from Spencer or St. Vincent Gulf, South Australia. The type specimen was larger with disc diameter 6 mm. and differs from *alternata* in having the dorsal arm plates bell-shaped and longer than wide, the oral shields with a convex distal side and an acute proximal angle, the third oral papilla wide and rounded and only six arm spines even on the proximal segments. The moniliform arms, stressed by H. L. Clark in his key of 1946, are not very obvious in his photograph, appearing to be developed to about the same degree as in *O. alternata*.

A third Australian species of *Ophiacantha* comparable to this one is *O. clavigera* Koehler, 1907, known from the vicinities of Fremantle and Bunbury. That species has the upper arm spines markedly clavate (apparently more so than in *alternata*, judging from Koehler's diagrammatic figures), the arm plates, oral and adoral shields are similar to those of *alternata*, but the disc is covered only with stumps, while the underlying scaling is distinct (at least in the figures) and there is no alteration in the number of arm spines.

Among the Australian species of *Ophiacantha* the only one which has anything approaching the same peculiarity of the arm spines is *O. gracilis* (Studer), 1882 (Phys. Abh. K. Akad. Wiss., Berlin), from Torres Strait, the East Indies and Phillippines, which has the uppermost of the four arm spines particularly long on the second free segment, though there is no alternation on the following segments.

Amphiura poecila H. L. Clark.

Text fig. 5a–e.

Amphiura poecila H. L. Clark, 1915, p. 230, pl. 5, figs. 12, 13; 1946, pp. 197–198.

Amphiura rapida Koehler, 1930, pp. 99–100, pl. 16, figs. 11, 12.

MATERIAL.—Port Phillip Survey: Area 61 (96), 2 specimens.

Since neither H. L. Clark's photographs of the holotype of *A. poecila* nor Koehler's of that of *A. rapida* are altogether satisfactory, I give here some drawings I made of the Holotype whilst visiting the Museum of Comparative Zoology.

One of the two Port Phillip specimens has six arms.

The type locality of *A. poecila* is Westernport, Victoria.

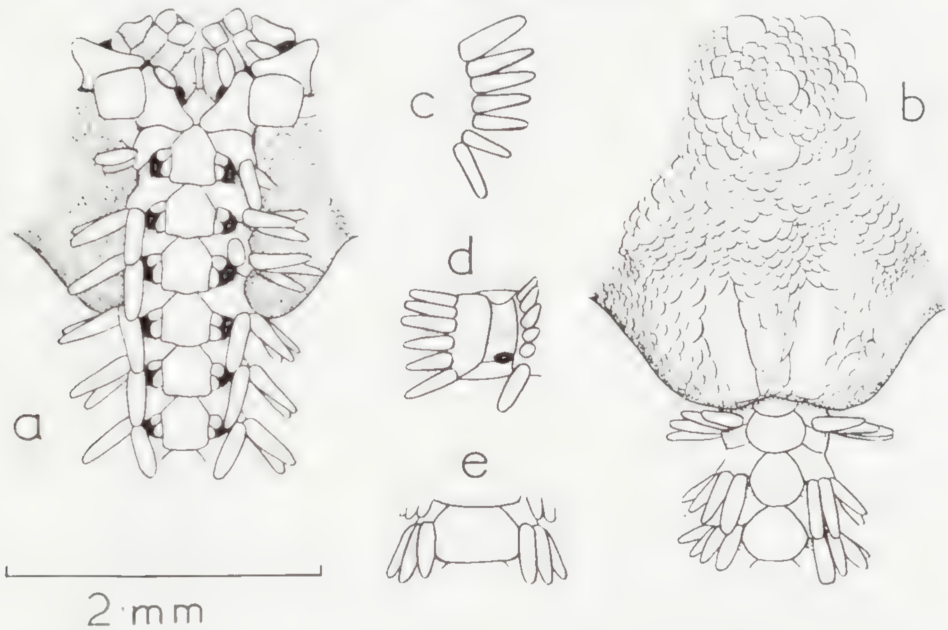

FIG. 5. **a–e** *Amphiura poecila* holotype, disc diameter 4 mm., **a** ventral and **b** dorsal views of part of the disc and an arm base, **c** arm spines in profile (the spatulate shape of the middle ones not apparent in this view), **d** lateral view of an arm segment, the spines more or less foreshortened, **e** arm segment with the fifteenth dorsal plate.

Amphiura elandiformis sp. nov.

Text fig. 6f–i.

MATERIAL.—Port Phillip Survey: Areas 7 (207) 3 specimens (two discs lacking); 13 (210) 6 specimens without discs; 20 (309) 7 complete and 7 specimens without discs; 21 (115) 2 specimens without discs; 23 (68) 1 specimen without discs; 32 (277) 2 specimen with disc detached but present; (Holotype National Museum No. H. 40); 33 (177) 2 specimens without discs; 43 (251) complete specimen, (263) 3 specimens, two discs lacking; 47 (258–9), 1 specimen without disc; 52 (252) 2 specimens without discs; 53 (253) 3 complete and 2 specimens without discs; 61 (241) 2 specimens without discs; 1 complete specimen; 63 (246) 8 complete specimens and 7 without discs; (249) 1 specimen without disc.

DESCRIPTION of Holotype.—Disc diameter probably 9 mm. originally but owing to interradial shrinkage now about 8 mm. Arms all broken but probably very long, over ten times the disc diameter.

The disc of this and all other specimens bulges out radially beyond the distal end of the radial shields and is strongly contracted interradially so that its shape is petaloid. The dorsal side is covered with small but thick scales, slightly larger around the radial shields. There are about fifteen scales on a line drawn across the interradius between the proximal ends of two radial shields. Not far from the centre of the disc there are two slightly larger circular scales, but neither is quite central and no primary radial scales can be detected. The radial shields are extremely narrow, just under 2 mm. long but only about 0·25 mm. wide, the ratio of length: maximum breadth being about 7·5:1. Some of the shields are overlain by the scales more than others and so are reduced in area. The two shields of each pair are in contact only at their distal ends, from which point they diverge but curve towards each other again proximally so that they resemble the horns of an eland as viewed from the front. A similar shape is found in *Amphioplus falcatus* Mortensen, 1933, from South Africa.

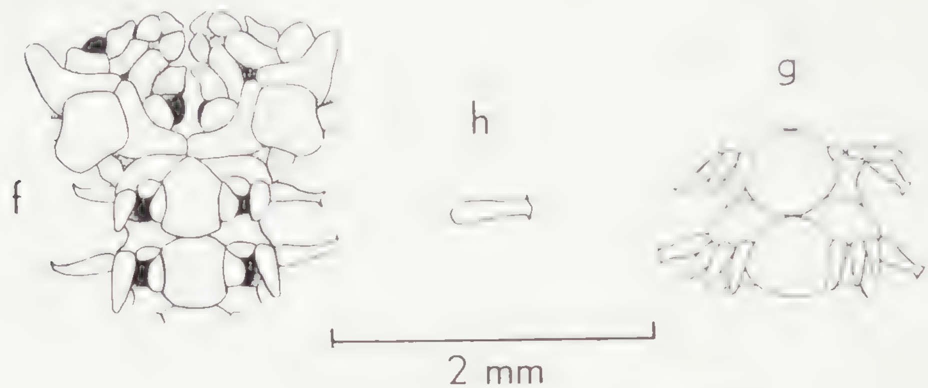

FIG. 6. **f–i** *Amphiura elandiformis*, Paratype, Port Phillip, disc diameter probably **c** 5–6 mm., **f** ventral view of two mouth angles and an arm base, **g** dorsal view of the ninth and tenth arm segments (with the second and third dorsal arm plates), **h** the second from lowest arm spine of the 23rd segment, **i** *A. elandiformis* holotype, part of disc and an arm base in dorsal view. (X marks the centre of the disc).

On the ventral side of the disc the scaling now stops short about halfway between the periphery and the distal edge of the oral frame, giving way to pale grey skin. This accounts for the frequent loss of the disc in this species. The extreme contraction of the ventral skin has probably pulled the scaling down to the ventral side and in life it is possible that the junction between scales and skin came at the ambitus or only a little below it. A similar condition is shown in all the other specimens that have the disc intact.

The oral shields have their widest part near the proximal end so that the proximal angle is obtuse; the distal lobe is long and hardly tapers until just short of its rounded end, so that the two longest sides are almost parallel. The length: breadth ratio is 1·3–1·5: 1 and the length is about 0·57 mm. In the paratype figured orally the shields widen out more than in the holotype, the shape figured being the most common one found in the present specimens, though one or two are even narrower throughout than in the holotype, having quite parallel sides. The madreporite is huge and swollen, almost 1mm. long and broad in proportion in the holotype. The adoral shields are broadly contiguous, both radially and interradially in the paratype figured, having a radial lobe covering the first ventral arm plate with the corresponding part of the neighbouring shield. In the holotype and most of the other specimens this radial lobe is less well developed and the shields are only contiguous interradially, the shape being quadrilateral, with no distal lobe between the oral shield and the first lateral arm plate. Opposite the second oral tentacle the proximal edge of the adoral is slightly concave. The distal oral papilla is very wide and rounded, almost opercular in shape. This form is the most common in the other specimens but one or two have a more angular shape with a distinct peak in the free edge, though the base is still very wide and exceeds the height. Usually these papillae are found in a semi-erect position but some have been preserved in the horizontal plane. The infradental papillae are quadrilateral in shape and the blunt inconspicuous oral tentacle scale lies just at the level of their dorsal edges.

The dorsal arm plates are approximately oval but with slight lateral angles; the distal half may be more deeply curved than the proximal which forms a rounded angle. The basal plates are small but, as the arms broaden out beyond the base, the dorsal plates increase in width at the same time. The fifth dorsal arm plate (on the fifteenth segment) has the length: breadth ratio 1 : 1·3, the breadth being 0·55 mm. and the arm width between segments at this point 0·85 mm. The twenty-fifth dorsal plate is 0·65 mm. wide and the arm breadth proximal to it is 1·0 mm. The consecutive dorsal arm plates are barely, if at all, contiguous.

The ventral arm plates are truncated pentagonal, longer than broad, with the distal edge slightly convex or sometimes straight in its middle part. All are contiguous.

The arm spines number five just beyond the disc; all of them taper evenly except for the second from lowest but the second has a hyaline tip which is bent into a slightly proximally directed hook on the basal segments or has a bihamulate form with the development of a second hook on the distal side. On the following segments this bihamulate spine increases in thickness and in the width of the tip but never reaches the size or convexity of tip attained by the comparable spine in *Amphiura*

(*Ophiopeltis*) *parviscutata*. The five spines of the fifth free segment on one arm (i.e. the fifteenth segment from the oral frame) measure respectively 0·40–0·45, 0·40, 0·29–0·31, 0·31 and 0·37–0·40 mm., beginning with the lowest one. By about the sixtieth segment (beyond which no arm remains intact) there are still five spines (except on one regenerated arm where the uppermost one is lost) and the first and bihamulate spines measure 0·53 and 0·47 mm.

The tentacle scales number two and are fairly large, especially the one on the ventral plate.

The colour in spirit is pale grey, though there are traces of light brown on the arm bases ventrally.

VARIATIONS.—A specimen with disc diameter c 6 mm. has the complete arm length 110 mm., a ratio of about 1: 18. Another with similar disc size has the arms c 105 mm.

In a few specimens the primary central disc scale is distinct and the five primary radials may be just recognizable, more by a dark spot of colour on each than by larger size. The radial shields are just under half the radial disc radius and are narrow and curved in all but a few specimens. Nine specimens have the length: breadth ratio varying from 4·7 to 8·0: 1, averaging 6·6: 1, the lowest value being for the smallest specimen, disc diameter 5·0 mm. The exceptions are provided by three of the specimens from off Dromana in which the discs are obviously in process of regeneration, being diminutive in relation to the width of the arms basally and there being more missing proximal dorsal arm plates than could ever be accounted for by shrinkage of the disc alone. The radial shields are much wider and shorter in these specimens, the ratio being 3·75, 2·8 and 2·3: 1, while the length of the shields is only about 1·2 mm. in the first two and 0·8 mm. in the third, compared with 1·7 mm. or 1·4 mm. in specimens with original (or at least fully grown) discs of about the same diameter. The disc scaling is also much coarser in these regenerating specimens and there are no traces of primary plates.

Several of the larger specimens with disc diameter 7·5 mm. or more have six arm spines on the proximal segments but still the second spine is the only one modified in shape.

There may be a conspicuous dark brown colour pattern on the proximal part of the arm, giving way fairly abruptly to the usual pale colour. One such specimen has the disc regenerating and conspicuously lighter in colour than the arm bases.

REMARKS.—Before 1963 this species was only represented in the Survey collections by a few discless specimens, so the original draft of my report only included figures of one of these under the name '*Amphiura* sp. aff. *diacritica*'. The discovery of complete specimens allowed me to name and fully describe the species which proved to be quite distinct from Queensland *A. diacritica* H. L. Clark. The latter has never been figured. It has long arms at least ten times the disc diameter, the dorsal side of the disc with very fine scales only around the radial shields, the rest, together with the ventral side, being skin covered; the radial shields are hardly more than twice as long as wide and the distal oral papilla is thick as well as wide. The species does resemble *A. elandiformis* in having some modified arm spines but there are eight

spines and the third and fourth, or other middle ones, rather than just the second, have the tip modified and this modification takes the form of a single hook, not two divergent ones.

A number of species of *Amphiura* have naked skin on much of the ventral side of the disc. Most of these have been grouped together by Fell (1962) as a separate, but I believe unnatural, genus, *Hemilepis*. Several are Australasian species. One of the closest to *A. elandiformis* is *A. norae* Benham, which I consider to be a synonym of *Amphiura correcta* Koehler described from an unknown locality but collected by Dumont d'Urville's expedition on the 'Astrolabe' to the Southern Ocean. I have examined a syntype of *A. correcta* in the Museum of Comparative Zoology and cannot find any character by which to differentiate it from the very distinctive *norae* described by Benham about two years later. *A. correcta* has fairly long, curved radial shields and very wide distal oral papillae but differs from *A. elandiformis* in having the arms not quite as long, only ten times the disc diameter, conspicuous primary disc scales, scales bordering the genital slits, spearhead-shaped oral shields widest nearer the distal end and particularly in lacking the specialized second arm spine. I regard this last character as an important one in assessing the relationships of Amphiurids. There are several species of the 'Hemilepis' group which do have the second spine and sometimes also the next one or two spines with modified tips. One of these is *A. fasciata* Mortensen from the Persian Gulf, in which there are eight spines proximally, the second and other middle ones being bihamulate. The radial shields are also fairly long in *fasciata* but it differs from *A. elandiformis* in having the disc more extensively skin covered, the distal oral papilla narrower and the oral shields and ventral arm plates of different shapes.

In *Amphiura uncinata* Koehler from the East Indies to South Africa the distal oral papilla is also wide and rounded but the modified arm spines have the form of distally-directed hooks. The antarctic species *A. joubini* Koehler does have bihamulate or hooked spines but differs in having the distal oral papilla spiniform and the radial shields relatively short. The Atlantic species *A. latispina* Ljungman has the second spine modified and oral shields of similar shape to *elandiformis* but differs in having the adorals widely separated interradially and the distal oral papilla conical, as well as the skin of the disc extending to the dorsal side interradially.

In H. L. Clark's key to the Australian species of *Amphiura* this species runs down to *A. ambigua* Koehler, recorded by Koehler from the East Indies and Siam but also occurring at Darwin according to H. L. Clark. Since the latter's key gives *ambigua* as a species with the disc skin-covered ventrally, whereas Koehler's specimens, one of which I have seen, are fully scaled on both sides, I am doubtful of the identification of the Darwin specimens. *A. ambigua* has oral shields and small thick disc scales like *elandiformis* but the second *and* third arm spines are bihamulate, the radial shields are wider, the distal oral papilla is cylindrical and of course the disc is scaled ventrally. Zoogeographically it is improbable that the same species is found in Port Phillip as on the north coast of Australia but if H. L. Clark's specimens from Darwin do have the disc skin-covered below, narrow radial shields, long arms and hooks on two of the arm spines then they may be related to *A. elandiformis*.

Having examined the types of both species, I should point out that, contrary to H. L. Clark's key, the holotype of his species *A. multiremula* also has scales on the ventral side of the disc and *A. stictacantha* has two tentacle scales rather than one and so should come in the second half of the key.

To sum up, the combination of very long arms, very narrow radial shields, partial ventral skin covering, unusual oral shields, wide rounded distal oral papillae and bihamulate second arm spines is matched by no other species of *Amphiura* as far as I know.

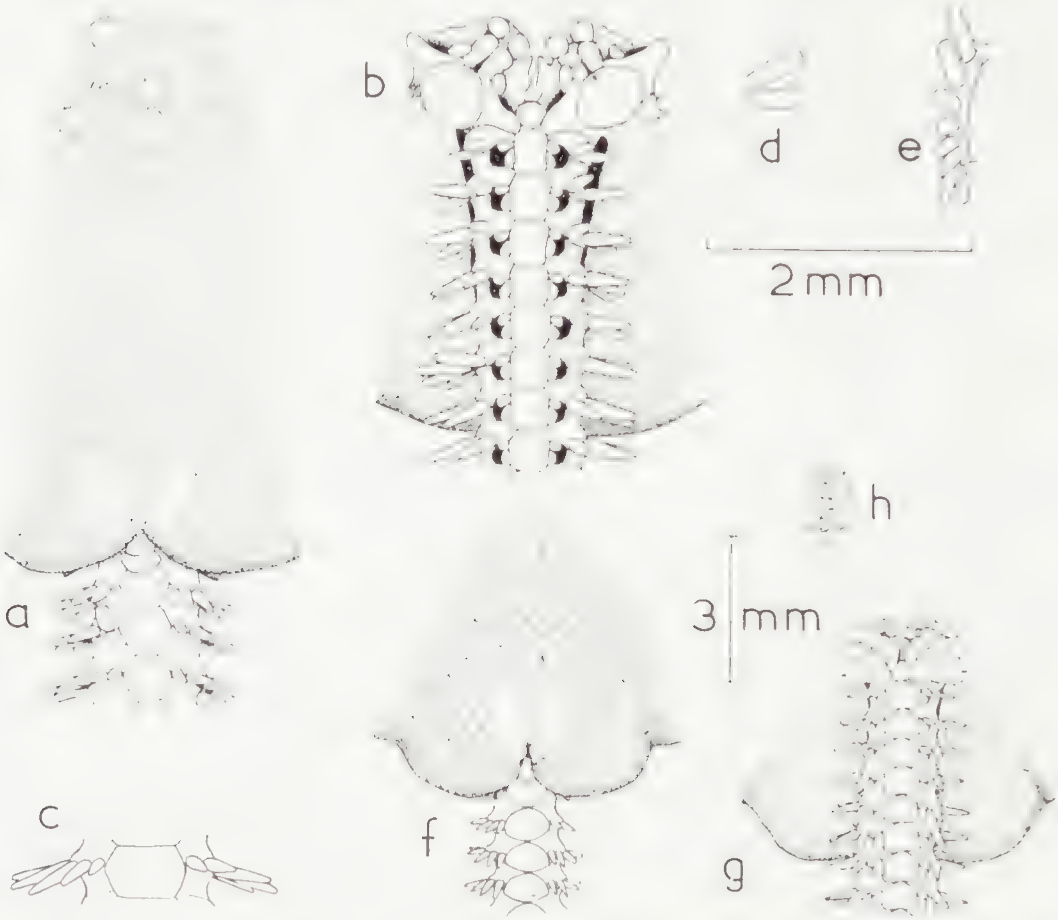

FIG. 7. **a–e** *Amphiura multiremula* holotype, disc diameter 7 mm., **a** dorsal and **b** ventral views of part of the disc and an arm base, **c** the segment with the 20th dorsal arm plate, **d** view of the two uppermost arm spines from the distal side, **e** lateral (and slightly dorsal) view of the second free arm segment, the middle spines foreshortened, **f–h** *A. dolia* paratype, Port Jackson, disc diameter c. 9 mm., **f** dorsal and **g** ventral views of part of the disc and an arm base (the oral shield on the right being the madreporite), **h** lateral view of the fourth free arm segment. (The 2 mm. scale applies to **a–e** and the 3 mm. one to **f–h**.)

There are two species of *Amphiura* with two tentacle scales known from New South Wales that have some features in common with this one, namely *A. dolia* and *A. multiremula* both of H. L. Clark, 1938. Neither of these has been properly figured and this seems to be a good opportunity

to publish drawings of a paratype of *A. dolia* and of the holotype of *A. multiremula* (fig. 7). It can be seen from these that *A. dolia* has opercular distal oral papillae like the Port Phillip form but differs in the shape of the oral shields, ventral arm plates and the absence of hooks on any of the spines, while *A multiremula* has similar ventral arm plates but spatular upper arm spines and small elongate distal oral papillae.

Amphuira (*Ophiopeltis*) *parviscutata* sp. nov.

Text–fig. 8.

MATERIAL.—Port Phillip Survey: Area 25 (299), 1 specimen (without disc); 26 (126), 3 specimens without disc; 27 (302), 1 specimen (without disc); 39 (312), 2 specimens complete one without disc; 55 (147), one complete specimen (Holotype National Museum No. H 17).

DESCRIPTION of the Holotype.—The disc diameter is about 4 mm. but it has probably shrunk since all the arms are pulled upwards basally and their exposed basal segments have their dorsal arm plates reduced or even absent. In life the diameter was probably about 5 mm. The arms are coiled up in a tangle and it is impossible to give an accurate estimate of their length; it was probably at least 20 times the disc diameter.

The disc is covered with very thin and completely transparent skin so that the underlying organs can be clearly seen. The radial shields are long and narrow, nearly 1 mm. long but only a fifth or a sixth as wide. Their sides are almost parallel and the two shields of each pair are in contact for most of their length. (This might be attributable to the shrinkage of the skin, but they were probably parallel in life, if not in actual contact.) There may be a very few fine scales proximal to the shields where the skin becomes slightly opaque when the specimen is half dried. On the ventral side the disc is equally transparent and the only scales are single rows along the edges of the genital slits. The skin is carried from the disc on to the oral plates so that the oral shields, except the one which is modified as the madreporite, are concealed in the skin and only become visible when the specimen is allowed to dry somewhat. Even so, one interradius completely lacks the oral shield and in the three others the shield is very small, not in contact with the widely separated triangular adoral shields which lie on each side of it. These three oral shields are about twice as wide as long. At the inner (interradial) tip of each adoral shield is a small conical distal oral papilla, about two or three times as long as wide; most of these papillae have been damaged. The infra-dental papillae and oral tentacle-scales are as usual, the latter are at a slightly higher level and have blunt tips.

The proximal dorsal arm plates are about as long as wide, widest in the middle of their length, with a proximal angle and a deep distal curve. Further out on the arm the widest part of the plate is nearer the proximal end and the proximal angle is nearly 180°. The widest plates have the length: breadth ratio 1 : 1·15. The successive plates are mostly just in contact. The ventral arm plates are pentagonal, slightly longer than wide and the proximal angle of each one just touches the distal side of the preceding plate (at least in the proximal part of the arm). The lateral arm plates bear four arm spines each side, of which the two uppermost and the lowest one taper to a point, while the second from lowest develops a conspicuous, flattened, bihamulate or axe-headed tip on the segments beyond the base of the arm.

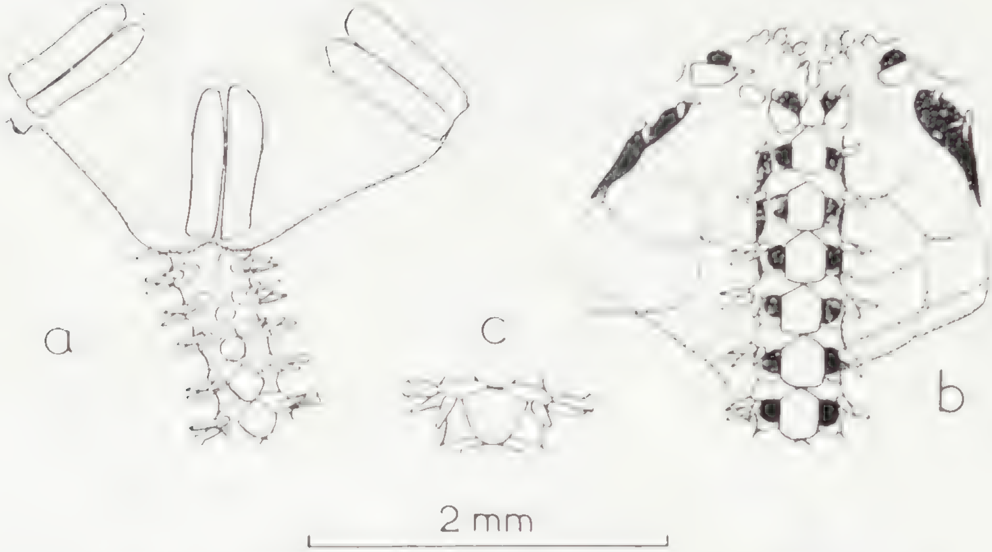

FIG. 8. *Amphiura (Ophiopeltis) parviscutata* holotype, disc diameter 3–4 mm., **a** dorsal and **b** ventral views of part of the disc and an arm base, **c** dorsal view of an arm segment, approximately the 45th.

The disc-less specimens are similar to the type in their mouth parts and arm plates, the oral shields being particularly small and either isolated or only just bridging the gap between the adoral shields; odd oral shields may be lacking altogether; the bihamulate arm spine is present in all of them.

AFFINITIES.—In trying too identify these specimens I thought at one time that they might be conspecific with *Ophiolepis perplexa* Stimpson, 1855. That species was referred to *Amphiura* by Lyman, 1882 and to *Ophionephthys* by H. L. Clark, 1946, while Fell, 1962, refers it to his new genus *Icalia* since its mouth parts differ from those of the West Indian type species of *Ophionephthys*, *O. limicola* Lütken. Also the dorsal side of the disc is described as covered with fine scales and its radial shields are inwardly divergent. Stimpson makes no mention of any of the five arm spines being other than pointed. The type locality of *perplexa* is Port Jackson and I can find no published records for it since the original one.

There is no doubt that *parviscutata* is very closely related to the North Atlantic species *Ophiopeltis securigera* Düben and Koren, 1845, the type species of the genus *Ophiopeltis* so long submerged in *Amphiura* but recently revived by Fell. Both species have the radial shields bar-like with only a suggestion of scaling proximal to them, the disc otherwise completely naked, the adoral shields separated, the second from lowest arm spine bihamulate, the number of spines proximally four and the arms extremely long. The only difference seems to be that the oral shields of the Port Phillip species are more reduced than those of *securigera*.

Other species which are related to *parvisculata* are *Ophionema hexactis* Mortensen and *Ophionephthys iranica* Mortensen (both from the Persian Gulf), also *Ophionephthys tenuis* H. L. Clark from north-west Australia. Of these, *O. iranica* was referred to *Ophiopeltis* by Fell and *O. tenuis* to

Ophionema, although Mortensen stated (after studying a syntype of *O. tenuis*) that the two species are closely related to one another. Since Mortensen commented that in one specimen of *iranica* the second spine is 'thorny or axe-shaped as in typical *tenuis*', it seems that both species approach *parviscutata* in this character and all three should be considered as congeneric. However, *parviscutata* is still distinguished by its reduced oral shields.

As for the generic position of this species, I believe that Fell's subdivisions of *Amphiura* are not sufficiently distinct from each other or natural in their limits to rank as genera, though some of the species he has referred to *Ophiopeltis* do form a natural group. However, the existence of intermediate species such as *Amphiura borealis* Sars suggests that this group should be ranked no higher than a subgenus. I must protest against Fell's assumption that subgenera are only a stage in time on the way to consideration as genera. The progress of taxonomic thought may also go in the opposite direction on occasion, reducing nominal genera to subgenera or even synonyms of others. Accordingly, I give this new species the trinomial *Amphiura* (*Ophiopeltis*) *parviscutata*.

Ophiocentrus pilosus (Lyman).

Pl. IV., figs. 1–3.

Ophiocnida pilosa Lyman, 1879, p. 32, pl. 12, figs. 341–343; 1882, pp. 153–154, pl. 19, figs. 7–9; H. L. Clark, 1909, pp. 541–542.

Ophiocentrus pilosus Gislén, 1926, p. 13; H. L. Clark, 1938, p. 237; 1946, pp. 199–200.

MATERIAL.—Port Phillip Survey: Areas 26, (126), 8 specimens; 27 (45) 1 specimen; 29 (289) 2 specimens, 38 (311) 2 specimens; 39 (312) 1 specimen; 68 (220) 1 specimen.

The holotype of *O. pilosus* from Bass Strait is in the British Museum. It has the disc only 5·2 mm. in diameter. Lyman gives the number of arm spines as five but in fact there are six spines on each side of the first three to five segments. The smallest specimen collected by the Survey has the disc 7 mm. in diameter and the proximal arm segments have seven spines each side, which might be expected at this size. The largest specimen has the disc diameter 17 mm. and the arms at least 140 mm. long; it has ten spines proximally. Although in the holotype the disc scales are mostly distinct even when wet, in all these specimens the scales are obscured by skin, which is thickest and most nearly opaque in the larger specimens. Even in these, there is a wrinkling of the skin which may give the impression of fine scaling and possibly does correspond to the underlying scales.

In 1926 Gislén split off as *Ophiocentrus novaezelandiae* the specimens from New Zealand (and provisionally also those from New South Wales) which were described under the name of *Amphiocnida pilosa* by Mortensen in 1925 (pp 154–157). In the British Museum collections, apart from the very small specimen with disc diameter only 2 mm. collected by the 'Discovery' Investigations in New Zealand waters, there is only a single arm of a specimen of *O. novaezelandiae* from Cook Strait. This is comparable in size to the arms of the largest Port Phillip specimen but differs in having the arm plates relatively a little wider and the spines

(which number only eight proximally) relatively longer, all but the two uppermost being longer than the segment; the spines are also distinctly spatulate in shape. The widest ventral arm plates are 0·8 mm. long and 1·0 mm. wide; the corresponding dorsal arm plates are 0·8 mm. long and 1·3 mm. wide; the longest arm spines (the *two* lowest ones) are both about 1·3 mm. long. In the largest specimen of *O. pilosus* the ventral arm plates are barely wider than long, the length being 0·7 mm. and the width 0·85 mm.; the dorsal arm plates are 0·7 mm. long and 1·0 mm. wide and the lowest arm spine is c. 0·95 mm. long, the next spine being appreciably shorter, so that only the lowest spine is distinctly longer than the segment.

Mortensen showed how variable his specimens were with regard to the form and proportions of the arm plates (though this was to some extent probably correlated with size) and of the oral shields. Gislén distinguished *O. novaezelandiae* by the large size and distinctness of the disc scaling and the supposedly larger number of arm spines than in *O. pilosus*. Since the disc scales are also distinct in the type specimen of *O. pilosus* and their distinctness may be due to the state of preservation and since the number of arm spines varies with size, neither character seems reliable. Possibly the relatively longer spines and the similarity between the lowest spine and those immediately above it, as well as the relatively greater width of the dorsal and ventral arm plates, may prove to be sufficiently constant to justify the retention of a New Zealand species.

Another species of *Ophiocentrus*, *O. fragilis* H. L. Clark, 1938, also has its type locality in south-east Australia. It is known only from the holotype which was taken off New South Wales and in which the disc diameter was 5 mm. This was supposed by Dr. Clark to differ from *O. pilosus* by having the disc scales relatively large and obscured only by their spinelets, not by skin, also in having the second from lowest arm spine bihamulate. However, in contradiction to H. L. Clark's key, the second from the lowest (and to a lesser extent the following) spines of *O. pilosus* are distinctly square-tipped and some of them might be described as bihamulate. The slightly oblique flattening of the arm spines causes them to appear slender and tapering when viewed at certain angles. Another feature supposedly characteristic of *O. fragilis* is the transparency and microscopically pitted texture of the dorsal arm plates, but this is common to most species of *Ophiocentrus*, including *O. pilosus*, the plates being delicate especially in smaller specimens. [I suspect that this same transparency of the plates showing a dark mid-radial line may account for the allegedly keeled condition of the plates described by Brock in *O. alboviridis*.] However, *O. fragilis* may be marked off by the enlargement of the uppermost arm spine as well as the lowermost and by the relatively longer radial shields, which were six times as long as wide in the holotype, whereas in *O. pilosus* they are usually about four times as long as wide (even shorter in the type specimen).

Some other characters used in H. L. Clark's key to the Australian species of *Ophiocentrus* are incorrect. Firstly, he distinguished O. *dilatatus* from *pilosus* and *asper* by the widening of its arms beyond the base. In the larger Port Phillip specimens of *O. pilosus* the arm spines, if not the arms themselves, have a wider span some way beyond the base of the arm. The largest specimen has the span of arm and spines (extending at right angles) 3·2 mm. basally but 4·2 mm. at a distance of 30 mm. from the

disc. Also the dorsal arm plates are *not* longer than wide (except on the basal segments) in *Ophiocentrus verticillatus*, as can be seen from Döderlein's photograph of the holotype (1896, *in* Semon, Zool. Forsch. Aust. und Malay, Archip., Ophiuroidea, pl. 15, fig. 7).

Some of the characters used in Gislén's key of 1926 are also misleading. Certain features, such as the number of arm spines and the relative width of the arm plates, are influenced by size. On some other points he is mistaken. The dorsal arm plates are only longer than broad on the *basal* segments in *O. asper*, further out they become broader than long; the separation of the radial shields in *O. vexator* is almost certainly due to poor preservation and the flattening of the disc spinelets is not peculiar to the unique holotype of *O. putnami*, but can also be seen in similarly large specimens of *O. pilosus*.

One other species of *Ophiocentrus* has been recorded from south-east Australia; this is *O. asper* (Koehler), which Koehler himself recorded in 1930 from a single specimen taken off Cape Howe, at the same time giving many East Indian stations, without commenting on the specimen itself or the extension of range from the East Indian area that it provided. As H. L. Clark suggested in 1946, this identification may have been a mistake for *O. pilosus*, from which *O. asper* is not very sharply distinguished.

The entire genus *Ophiocentrus* is badly in need of revision. So little account has been taken of variation and growth changes in most of the characters used to distinguish the species that several of the names adopted must prove to be synonyms. The 'Challenger' specimen from station 212 in the Philippines is certainly conspecific with *Ophiocentrus inequalis* (H. L. Clark), 1915, rather than with *O. pilosus*. The type locality of *O. inequalis* was Hong Kong; the holotype, which I have examined and drawn, is in the Museum of Comparative Zoology. The British Museum collection also includes two specimens from Macclesfield Bank in the South China Sea which can be referred to this species At present the following East Indian species of *Ophiocentrus* are recognized:—*aculeatus* Ljungman, 1867, *putnami* (Lyman), 1871, *alboviridis* (Brock), 1888, *verticillatus* (Döderlein), 1896, *asper* (Koehler), 1905, *dilatatus* (Koehler), 1905, *inequalis* (H. L. Clark), 1915, *vexator* Koehler, 1922, and *koehleri* Gislén, 1926, however I doubt whether all these are valid.

ECHINOIDEA.

KEY TO THE ECHINOIDS OF THE EAST FLINDERSIAN REGION

(derived partly from Mortensen's monograph.)

1. (32) 'Regular' radially symmetrical echinoids with ambitus circular and anus and mouth in the centres of the upper and lower sides.

2. (5) Primary spines few and very large; their surfaces skin-less and roughened; secondary spines much smaller, forming rings around the primaries and rows up the ambulacra; peristome covered with plates.

3. (4) Surface of primary spines usually irregular, with tubercles or thorns, the tips of the spines often flared; apical system rather large, its diameter a third to half the total horizontal diameter; usually some or all ocular plates insert (i.e., contacting the periproct between the genital plates). . . . .
Goniocidaris tubaria f. *impressa* Koehler, 1926.

4. (3) Surface of primary spines uniformly granular, their tips rounded; apical system smaller, less than a third the horizontal diameter; oculars all widely exsert (separated from the periproct by the contiguous adjacent genital plates). *Phyllacanthus irregularis* Mortensen, 1928.

5. (2) Primary spines numerous, neither conspicuously large and isolated nor markedly different from the secondary spines; peristome covered with skin.

6. (29) Ambulacral plates trigeminate, each compound one with three pairs of pores, the pore-pairs arranged either in arcs of three, a vertical row or irregularly.

7. (8) Primary tubercles distinctly crenulate (i.e. with a ring of small knobs around the boss); conspicuous pits between the angles of the plates; test low and hemispherical. .. .. *Temnopleurus michaelseni* (Döderlein), 1914.

8. (7) Primary tubercles hardly, if at all, crenulate; no angular pits but sometimes small hollows or pores present test usually high and more or less globular.

9. (26) All the ambulacral plates with a primary tubercle.

10. (17) Sutures of the interambulacral plates bordered by more or less bare areas.

11. (12) Ambulacral plates numerous, more than 25 in each series, when the horizontal diameter is only 12·5 mm. (as in the unique type); edges of the plates white. .. .. .. *Microcyphus pulchellus* H. L. Clark, 1928.

12. (11) Ambulacral plates fewer, less than twenty at this size; edges of plates not white.

13. (14) Peristome smaller than the apical system; arm spines each with a broad red band. .. .. .. *Microcyphus annulatus* Mortensen, 1904.

14. (13) Peristome larger than the apical system; spines not banded.

15. (16) Bare interambulacral areas dark. *Microcyphus zigzag* L. Agassiz *in* Agassiz & Désor, 1846.

16. (15) Bare interambulacral areas rose red. *Microcyphus compsus* H. L. Clark, 1912.

17. (10) No bare patches along the interambulacral sutures.

18. (23) Tubercles and their accompanying spines present on the plates of the periproct.

19. (20) Pore arcs very sloping, so that the pores also form three vertical series. *Amblypneustes pachistus* H. L. Clark, 1912.

20. (19) Pore arcs not very oblique, so that vertical series are not obvious.

21. (22) Test globular, not patterned with radiating stripes *Amblypneustes ovum* (Lamarck), 1816.

22. (21) Test low, hemispherical, striped. .. *Amblypneustes grandis* H. L. Clark, 1912.

23. (18) Plates of the periproct bare.

24. (25) Secondary spines reddish; a dark brownish spot below each primary tubercle. *Amblypneustes formosus* Valenciennes, 1846.

25. (24) Secondary spines greenish or whitish; no brown spots on test *Amblypneustes pallidus* (Lamarck), 1816.

26. (9) A primary tubercle only on every second or third ambulacral plate.

27. (28) Ambulacra distinctly wider than the interambulacra; pore zones comprising two dense vertical marginal series of pore-pairs with irregularly placed pore-pairs between. *Holopneustes porosissimus* L. Agassiz *in* Agassiz & Désor, 1846.

28. (27) Ambulacra not wider than the interambulacra; pore pairs forming three regular vertical series. .. *Holopneustes inflatus* Lütken *in* A. Agassiz, 1872.

29. (6) Ambulacral plates polyporous, with arcs of four or more pairs of pores.

30. (31) Four or five pore-pairs in each arc. *Pachycentrotus australiae* (Michelin *in* A. Agassiz), 1872.

31. (30) Seven or eight (rarely nine) pore-pairs in each arc. *Heliocidaris erythrogramma* (Valenciennes), 1846.

32. (1) Irregular echinoids, with some degree of bilateral symmetry, the ambitus more or less oval, the anus always and the mouth sometimes excentric.

33. (46) Mouth more or less central (not shifted anteriorly); peristome circular; test more or less flattened; petaloid areas on the upper side flat or slightly convex, never sunken.

34. (41) Size moderate to large, length usually well over 20 mm.; test more or less discoidal or conical, with a marginal area which is either thin and sharp at the edge or at least lower than the central part if the edge is thicker and more rounded; pore areas of the upper side forming very distinct petals.

35. (40) Petals wide open distally miliary spines of the upper surface simply rugose, not ending in a flared crown.

36. (37) Five genital pores; the pore series of the paired petals incurved distally; test high conical, with a fairly thick margin
Clypeaster australasiae (Gray), 1851.

37. (36) Four genital pores; paired petals wide open distally; test low, discoidal.

38. (39) Test nearly circular; anterior petal nearly twice as long as wide
Ammotrophus cyclius H. L. Clark, 1928.

39. (38) Test distinctly wider than long; anterior petal short, less than half again as long as wide .. .. *Ammotrophus platyterus* H. L. Clark, 1928.

40. (35) Petals tapering and closed distally miliary spines of the upper side smooth but ending in a flared crown .. .. *Peronella peroni* (L. Agassiz), 1841.

41. (34) Size small, length not exceeding 20 mm. and usually less than 10 mm.; test "bun-shaped" with a thick rounded margin and the centre hardly, if at all, higher; petals not well-developed, but indistinct.

42. (43) Test low flattened, length over four times the height; internal radiating partitions present .. .. *Echinocyamus platytatus* H. L. Clark, 1914.

43. (42) Test higher, ovate, less than three times as long as high; no internal partitions.

44. (45) Test ovoid, length less than twice the height *Fibularia ovulum* Lamarck, 1816*.

45. (44) Test flatter, between two and three times as long as high
Fibularia plateia H. L. Clark, 1928.

46. (33) Mouth more or less anterior, never central, though still on the under side of the test; peristome crescentic or semicircular; test ovoid, never very flattened; petals usually more or less sunken, at least the paired ones.

47. (56) A peripetalous fasciole present (i.e. a distinct belt of crowded, fine, ciliated spinelets running around the whole petaloid area on the upper side of the test).

48. (53) A latero-anal fasciole (leading back from the peripetalous one on each side and running below the anus) present.

49. (50) Four genital pores .. .. .. *Protenaster australis* (Gray), 1851.

50. (49) Two genital pores.

51. (52) A distinct hollow below the anus on the posterior side of the test
Moira lethe Mortensen, 1930†.

52 (51) No pronounced hollow posteriorly. *Moira stygia* Lütken in A. Agassiz, 1872†.

53. (48) No latero-anal fasciole, only a closed sub-anal fasciole in addition to but quite unconnected with the peripetalous one.

54. (55) Paired petals sunken; peripetalous fasciole indented more or less between the petals .. .. .. *Brissus meridionalis* Mortensen, 1950**.

55. (54) Paired petals not at all sunken but flush with the rest of the test; peripetalous fasciole oval, not indented between the petals
Eupatagus valenciennesi L. Agassiz *in* Agassiz & Désor, 1847.

56. (47) No peripetalous fasciole present but only an inner one, looping around the anterior petal and the apical system only
Echinocardium cordatum (Pennant), 1777.

* Mortensen (1948) has shown that *Echinocyamus craniolaris* Leske, 1778, which name was used for this specie by H. L. Clark, is a synonym of *E. pusillus* (O. F. Müller), 1776; the proper name for this Indo-Pacific species is therefore *Fibularia ovulum* Lamarck.

† Mortensen (1951) points out that the specimens recorded as *M. stygia* by H. L. Clark are really referable to *M. lethe* but he has himself seen a specimen from Port Elliot, South Australia, which is more like, if not identical with, *M. stygia*.

** Mortensen (1951) doubts the occurrence in the south of Australia of *Brissus latecarinatus* to which species H. L. Clark referred a number of Australian specimens. Re-examination of a specimen in the British Museum from Adelaide and two others from the vicinity of Fremantle, Western Australia, all formerly named *latecarinatus*, showed that these have the test vertical posterity and should be referred to *meridionalis*.

HOLOTHURIOIDEA.

Owing to the incomplete descriptions made by Joshua (1914) and Joshua and Creed (1915), there has been uncertainty about the identities and affinities of some of the holothurian species that are found in Victorian and South Australian waters. A recent paper by Hickman (1962) on Tasmanian holothurians helps to relieve the situation, since he gives descriptions, figures and photographs of a number of the species.

The following key was prepared before seeing Hickman's paper. His key does include most of the species found in Port Phillip but also introduces several new species (*Psolidium ravum*, *Psolidiella adhaerens* and *Paracaudina luticola* as well as a new genus and species *Neoamphicyclus lividus*), all from Tasmania. However, it excludes some of the South Australian species which I had given a place in my key in case their ranges should prove to extend further east. Because of this exclusion and for the sake of completeness I think it is worth while to retain my key to supplement Professor Hickman's.

The only novelty to the Australian fauna list, introduced here is the Cucumariid genus *Stereoderma* which is represented by some diminutive specimens from Port Phillip.

KEY TO THE HOLOTHURIANS OF THE EAST FLINDERSIAN REGION.

1. (28) Tube feet present, either scattered or arranged in rows along the radii.

2. (7) Tentacles relatively small and peltate (i.e. with the stalk ending abruptly in numerous branches lying in a single plane making an oval- or shield-shape); size often very large, length exceeding 100 mm.; tube feet always irregular in arrangement.

3. (6) Deposits in the body wall not including buttons, but only tables, possibly also C-shaped spicules and small rosettes.

4. (5) Tables regular with large, smooth-edged discs and regular spires (or legs); no C-shaped spicules .. .. .. *Stichopus mollis* (Hutton), 1872.

5. (4) Tables irregular, edges of discs rough or spinous and spires uneven; C-shaped spicules present .. .. .. *Stichopus ludwigi* Erwe, 1913.

6. (3) Deposits also include buttons with three or more pairs of holes *Holothuria hartmeyeri* Erwe, 1913.

7. (2) Tentacles relatively large and bush-like with irregular branching, capable of being wholly retracted within the body wall together with the thin-walled introvert; mostly small species much less than 100 mm. long, though with a few exceptions; tube feet often limited to the radii.

8. (17) Tentacles 20 or 25, at least ten of them smaller than the others.

9. (14) Tentacles 20, five pairs of large ones alternating with five pairs of small; few, if any, spicules in the body wall, only some tables in the introvert.

10. (11) Calcareous ring with a very long cylindrical part made up of a mosaic of small plates and longer than or equalling in length the slender posterior prolongations .. *Neothyonidium dearmatum* (Dendy & Hindle), 1907.

11. (10) Calcareous ring short with few pieces and no long cylindrical portion, the posterior prolongations short and tapering.

12. (13) Tube feet similarly developed and evenly distributed all over the body wall *Lipotrapeza vestiens* (Joshua), 1914.

13. (12) Tube feet larger and more concentrated on the under side *Lipotrapeza ventripes* (Joshua & Creed), 1915.

14. (9) Tentacles 25.

15. (16) Three-legged tables present in the body wall
Cucumella mutans (Joshua), 1914.

16. (15) Few if any tables in the body wall, though some do occur in the introvert, but these have only two legs in the spire
Amphicyclus mortenseni Heding & Panning, 1954*.

17. (8) Tentacles ten, no more than two of them smaller than the others.

18. (19) Body with a well-developed ventral sole
Psolidium sp., see Joshua, 1914 and Hickman, 1962.

19. (18) No well-defined sole.

20. (23) Body wall almost rigid (at least in preserved specimens) with masses of knobbed perforated plates of varying sizes.

21. (22) Body quadrangular in cross-section; the smaller perforated plates fairly regular in shape; deposits also include baskets
Pentacta australis (Ludwig), 1875†

22. (21) Body not obviously quadrangular; perforated plates of varying sizes, the smaller ones more or less irregular in shape; no baskets .. *Stereoderma* sp.

23. (20) Body wall pliable; deposits comparitively rare, consisting of cruciform plates, rosettes, rods or tables, not knobbed buttons.

24. (27) Deposits cruciform plates, very small rosettes and sometimes also rods.

25. (26) Tube feet more or less concentrated along the radii; no vertical thorns near the corners of the cruciform plates; rods usually present also.
Staurothyone inconspicua (Bell), 1887.

26. (25) Tube feet not concentrated along the radii; thorns present near the corners of the cruciform plates, no rods. *Staurothyone vercoi* (Joshua & Creed), 1915.

27. (24) No cruciform plates in the body wall, only tables with a two-legged spire.
Thyone nigra (Joshua & Creed), 1915.

28. (1) No tube feet present.

29. (30) Size often very large, length often over 100 mm., body tapering at the ends; body wall thick and opaque, with simple curved rods deep in it and usually perforated plates with knobs nearer the surface.
Paracaudina australis (Semper), 1868.

30. (29) Size usually small, (except *Chiridota gigas*), body worm-like; body wall thin and sometimes semi-transparent, with anchors and anchor plates or else wheels and S-shaped bodies.

* Joshua and Creed (1915) recorded as *Pseudocucumis bicolumnatus* Dendy and Hindle (otherwise known from New Zealand) a specimen belonging to the South Australian Museum collected by Verco. Heding and Panning refer *bicolumnatus* to the synonyms of *Amphicyclus thomsoni* (Hutton), another New Zealand species, although the type specimen of *bicolumnatus* differed in having numerous two-legged tables in the body wall and was described as probably having 20 (rather than 25) tentacles. Accordingly Pawson (1962) has erected a new genus *Neocucumella* for type species *Pseudocucumis bicolumnatus*, which he considers to be valid and distinct from *Amphicyclus thomsoni*. It is possible that "*Cucumaria*" *striata* Joshua and Creed, from the Great Australian Bight, may also run down to this part of the key. It has tables in the body wall and so cannot be included in the Cucumariinae but might be referred either to the Thyoninae or to *Havelockia* (with synonym *Pentathyone* H. L. Clark) in the Sclerodactylinae (both sub-families of the Cucumariidae), or else to the Phyllophoridae should it prove to have more than ten tentacles. Membership of the Thyoninae is unlikely since Joshua and Creed noted that the calcareous ring is "of the usual generic configuration" (for *Cucumaria*, though sensu lato) and so presumably not like that of *Thyone* with its mosaic of plates and long posterior prolongations. The tables of "*Cucumaria*" *striata* have very tall, two-legged spires, something like those of *Mensamaria intercedens* from Malaysia and southern China.

†Cherbonnier (1952) has shown that *australia* is synonymous with the long-forgotten *Holothuria pentagona* Quoy & Gaimard, 1833. However, a proposition has been made to the International Commission on Zoological Nomenclature that the name *pentagona* among some others of Quoy and Gaimard, should be placed on the Official List of Rejected Names, to avoid further upset in the accustomed nomenclature. Another species which might run down here is the one that H. L. Clark (1946, p. 389) called *Cucumaria squamatoides* nom. nov. This name is a *nomen nudum* since it was based by H. L. Clark on a specimen from Encounter Bay, South Australia, which he had never seen, which had never been described or figured and about which Joshua and Creed, who named it *Cucumaria squamata* Ludwig, only said (1915, p. 17) that it is "quite in accord with Ludwig's description, both as to pedicel distribution and spiculation." The type locality of *C. squamata* was Kerguelen in the Southern Ocean and H. L. Clark quotes Deichmann (MS), who says that "one can be almost positive" that the name *squamata* was incorrect. I quite agree with this supposition judging from the geographical distribution of other echinoderms found at Kerguelen, but there is still insufficient foundation to satisfy article 13 of the International Code on Zoological Nomenclature, since *squamatoides* is a replacement name not for the Kerguelen species *squamata* but only for the specimen presumed to be incorrectly so named by Joshua and Creed. Until this specimen has been properly described, adequately figured and compared with related species it cannot be given a new name. *Cucumaria squamata* has large smooth perforated plates and baskets in the body wall and so presumably has this Australian specimen.

31. (34) Deposits anchors with anchor plates; tentacles normally twelve in number, pinnate in form.

32. (33) Anchor plates pear-shaped, with rounded lateral angles *Leptosynapta dolabrifera* (Stimpson), 1855.

33. (32) Anchor plates kite-shaped, the sides diverging evenly from the narrow end (i.e., that with the bridge for articulation with the anchor) out to distinct lateral angles. .. .. *Leptosynapta ictinodes* (H. L. Clark), 1924.

34. (31) Deposits wheels (sometimes localized in papillae) and sometimes also S-shaped bodies; tentacles ten or twelve in number, peltato-digitate in form, without a long median rachis.

35. (36) Twelve tentacles; no S-shaped bodies; size up to 500 mm. in life (much contracted when preserved). .. *Chiridota gigas* (Dendy & Hindle), 1907.

36. (35) Ten tentacles; S-shaped bodies present.

37. (38) Teeth on the inside edge of the rim of the wheels arranged in groups interrupted mid-way between the spokes; tentacles with 8–10 digits. *Trochodota allani* (Joshua), 1912.

38. (37) Teeth evenly spaced around the inside edge of the rim of the wheels; tentacles with four digits. .. .. .. *Trochodota roebucki* (Joshua), 1914.

Stereoderma.

This genus was established by Ayres, 1851, (Proc. Boston Soc. Nat. Hist., 4) for the species *Anaperus unisemita* Stimpson, 1851, from the Grand Banks, Newfoundland. That species (according to Deichmann, 1930, Bull. Mus. comp. Zool Harvard, *71*, p. 171) has the tube feet limited to the radii only on the mid-ventral radius, which is bordered on each side by smooth areas; laterally and dorsally the feet are uniformly scattered. The calcareous ring has no posterior prolongations. The deposits in the body wall are four-holed buttons of varying size with their surfaces either smooth or more or less knobbed, often more knobbly in one part than another. There is no end plate in the tube feet, but buttons and rods are present.

Stereoderma sp.

Text fig. 9.

MATERIAL.—Port Phillip Survey: South Channel Fort, area 62 (37), 2 specimens.

REMARKS.—The larger specimen is only 9 mm. long. It has a fairly hard body wall in which the larger, multi-layered perforated plates are visible under a low magnification. In addition to these, there are many more or less irregular smaller plates, mostly with knobs between the perforations, usually elongated and with one end smoother than the other, what Panning, 1951, (Zool. Anz., *146*, p. 75) calls fir-cone plates. There are no baskets such as occur in *Pentacta australis*. The tube feet appear to be limited to the radii, forming a zig-zag row in each radius, the bare interradial areas being narrower, at least in the preserved specimen. There are end plates in the feet, besides boomerang shaped rods with perforations particularly at the ends and at the angle in the middle. The calcareous ring has no posterior prolongations but is narrow and undulating. The colour is pale except for the eight large and two small tentacles which are brownish. The body is probably pentagonal in cross section, in comparison with the quadrangular form of *P. australis*. Another difference from *australis* and one which gives the generic distinction, is the absence of baskets in the body wall; besides this the plates include larger and more irregular though not so markedly knobbed ones.

The species which seems to be closest geographically and morphologically to this form from Port Phillip is *Stereoderma leoninoides* (Mortensen), 1925, from the Auckland Islands south of New Zealand. According to Mortensen *S. leoninoides* has the knobbed plates all much the same size, not so variable as here. Without a proper comparison I do not propose to create a new species on the basis of these two small specimens.

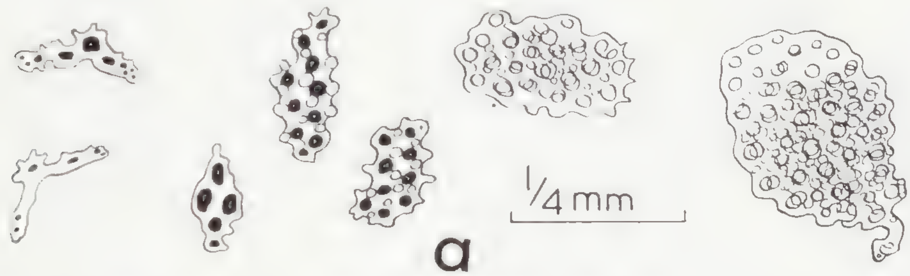

FIG. 9. a *Stereoderma* sp., Port Phillip, various spicules. (In the five smaller ones the holes are shown black but the thickness of the larger plates made this impracticable).

Pentacta australis (Ludwig).

Holothuria pentagona Quoy and Gaimard, 1833, p. 135.

Colochirus australis Ludwig, 1875, pp. 88–89, pl. 6, fig. 15.

Colochirus doliolum: Ludwig, 1887, pp. 1229–1231. [Non *Actinia doliolum* Pallas, 1766, which is a valid species of *Pentacta* from South Africa]. *C. doliolum:* Cotton and Godfrey, 1942, p. 230.

Pentacta australis: H. L. Clark, 1938, p. 445; 1946, p. 392.

Pentacta pentagona: Cherbonnier, 1952, pp. 33–35, figs. 12, 13, pl. 3, fig. 7.

NOMENCLATURE.—As the above synonymy shows, the proper name for this species is really *P. pentagona*, since Cherbonnier has declared that Quoy and Gaimard's type specimen of *pentagona* is conspecific with *P. australis* (Ludwig). However, since it is most undesirable that well-known names should be displaced by others which, since the publication recently of the International Code of Zoological Nomenclature, could be declared *nomina oblita* (not having being used for the last fifty years), a proposition is being made to the International Commission for the formal rejection of the name *Holothuria pentagona* Quoy and Gaimard (among some others of the same authors) and for the placing of *Colochirus australis* (Ludwig) on the Official List of Specific Names.

Thyone nigra Joshua and Creed.

Text fig. 10b, c.

Thyone nigra Joshua and Creed, 1915, pp. 20–21, pl. 3, figs. 3, 4; H. L. Clark, 1946, p. 401.

MATERIAL.—Port Phillip Survey: Areas 26 (300–1), 11 specimens; 27 (41), 1 specimen; (302), 1 specimen.

This seems to be only the second record of the species. The type was presumably from St. Vincent Gulf, South Australia. The tables of these specimens (fig. 10c) are irregular in shape, some of them being transitional

to the rods in the tube feet; the spires are low with only two legs. The calcareous ring is more complex than is shown in Joshua and Creed's figure, the main part being made up of a mosaic of mostly hexagonal plates though the posterior prolongations do have uniserial plates. In most of the specimens the whole ring is about 12 mm. long, approximately half this being made up by the posterior prolongations; this compares with a body length (contracted in preservation) of about 30 mm. The introvert together with the calcareous ring has become detached from the body in most cases. Normally the tentacles number ten, the two ventral ones being very reduced in size. In one specimen there are only six large tentacles and in another a dorsal tentacle is abnormally small like the ventral ones. The colour in spirit is dark purple shading to almost black on the tentacles and paling somewhat in the middle, more convex, part of the body. On some specimens a double row of tube feet can be distinguished along each radius among the other scattered feet all the feet being paler and more brownish in colour.

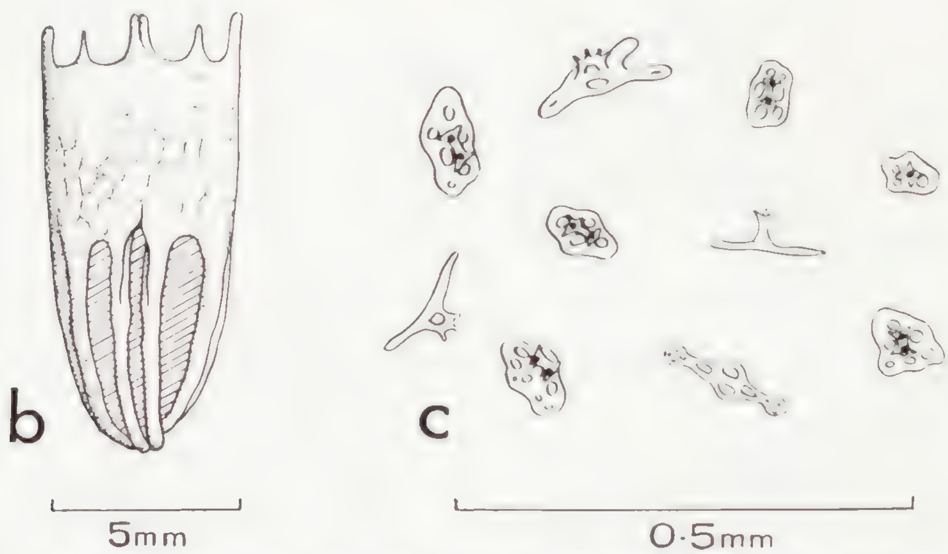

Fig. 10. **b–c** *Thyone nigra*, Corio Bay, Port Phillip, calcareous ring and spicules.

Cucumella mutans (Joshua)

Cucumaria mutan Joshua, 1914, p. 4, pl. 1, figs. 1a–d; Joshua and Creed, 1915, p. 18.

Cucumella mutans: Heding and Panning, 1954, pp. 67–68, fig. 17; Hickman, 1962, pp. 55–56, figs. 38–45, pl. 1, fig. 4.

MATERIAL.—Port Phillip Survey: Areas: 7 (123); 11 (125); 13 (92); 24 (Mordialloc Pier), 1 specimen; 26 (300–1), 1 specimen; 27 (41), 1 specimen; 28 (285), 1 specimen; 36 (75, 77); 42 (38)', 2 specimens; 55 (39, 148); 59 (25), 3 specimens; 63 (164), 2 specimens; various specimens not examined by A.M.C.

REMARKS.—Hickman has already pointed out that this species has 25 not 20 tentacles, as surmised by Heding and Panning, nor ten as given by Joshua. The long overdue description and figures which he provides

fully justify Heding and Panning's resurrection of *mutans* from the synonymy of *Mensamaria thomsoni* (or *Amphicyclus mortenseni*), where it was relegated by H. L. Clark, 1946. The difference in the number of tentacles may justify a generic distinction of this species from *Cucumella triplex*, consistent with the practise of Heding and Panning in dealing with the other genera of the family Phyllophoridae, but until adult specimens of the latter are forthcoming to show the definite number of tentacles, such a move is premature.

Port Phillip is the type locality of the species.

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PLATE I.

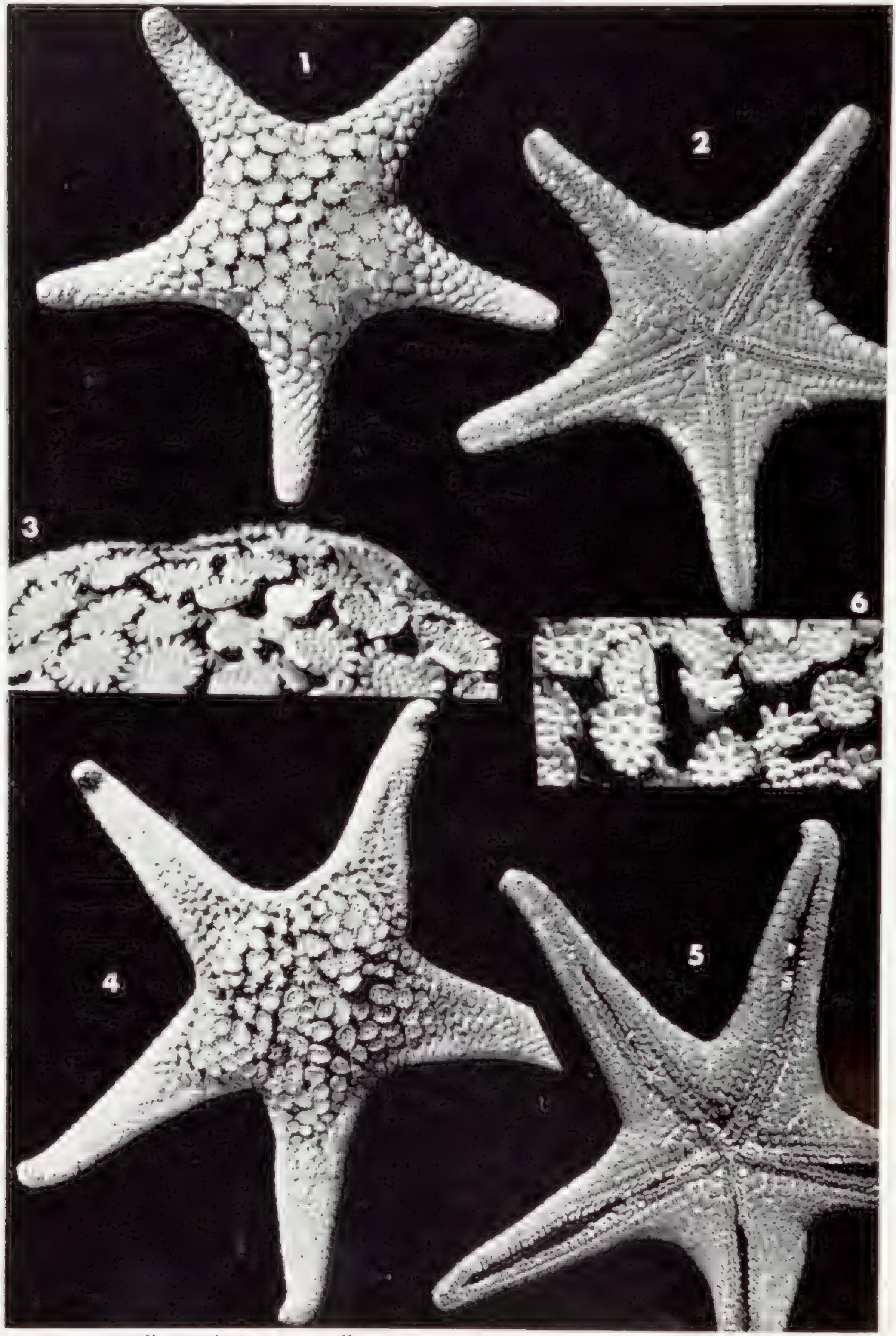

PLATE I. Figs. 1–3 *Nectria ocellifera* (Lamarck), Western Australian Museum specimen No. 362 (locality unknown), fig. 1 dorsal and fig. 2 ventral views, both x 2/3: fig. 3 detail of tabula viewed obliquely, x 2; figs. 4–6 *Nectria* cf. *ocellata*, Western Australian Museum specimen No. 19.59, Dunsborough, Western Australia, fig. 4 dorsal and fig. 5 ventral views, x 2/3, fig. 6 detail of tabula viewed obliquely, x 2.

PLATE II.

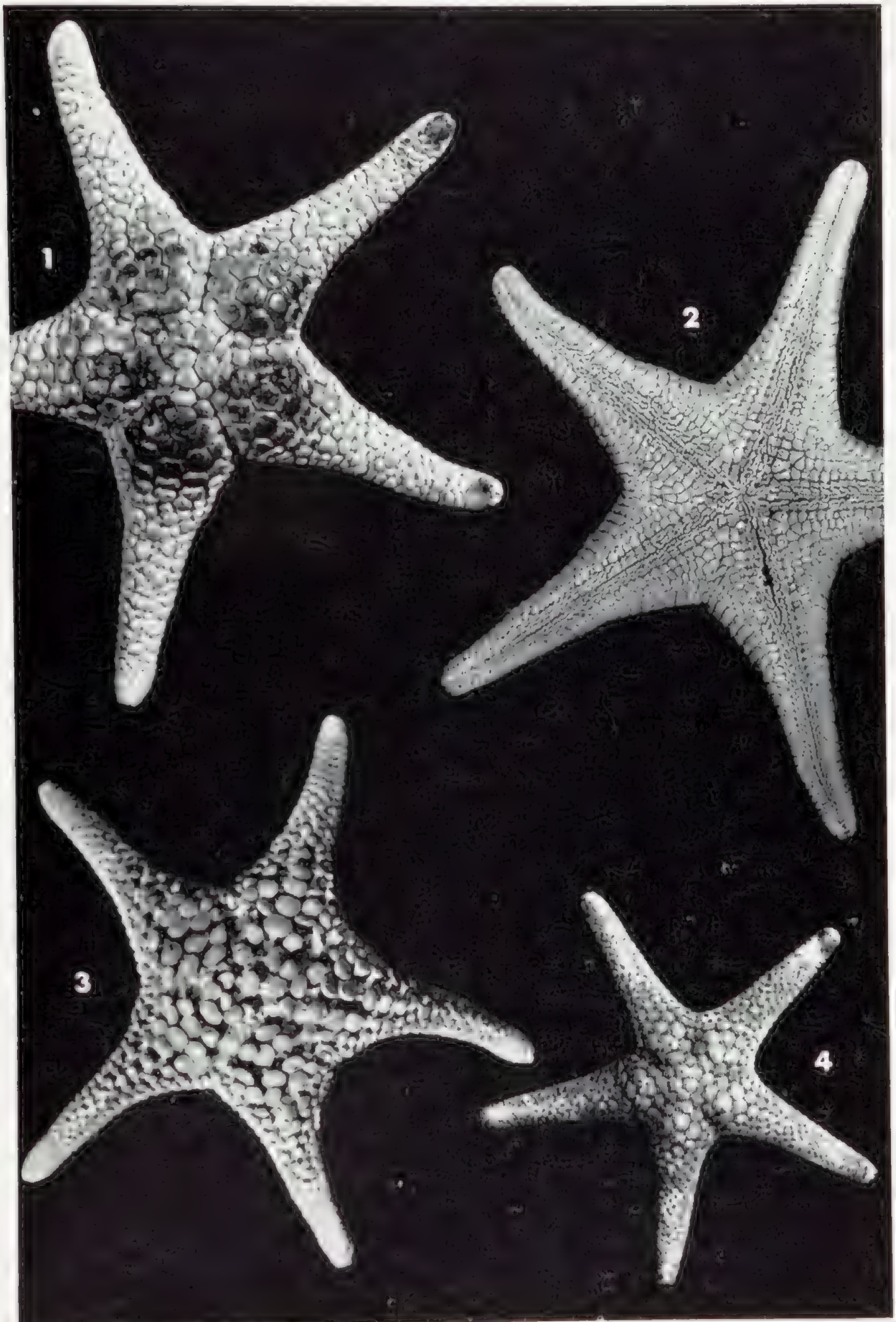

PLATE II. Figs. 1, 2 *Nectria multispina* H. L. Clark, B.M. No. 1962.4.9.7, Cape Schank, Victoria, fig. 1 dorsal and fig. 2 ventral views, x 2/3; fig. 3 *N. ocellata* Perrier. B.M. No. 1958.7.30.20, Tasmania, dorsal view, x 2/3; fig. 4 *N. ocellata* intermediate with *multispina*, B.M. No. 62.1.8.10, Tasmania, dorsal view, x 2/3.

PLATE III

PLATE III. Fig. 1 *Austrofromia polypora* (H. L. Clark), B.M. No. 85.11.19.69, Port Phillip Heads, dorsal view, × 2/3; figs. 2, 3 *Nectria macrobrachia* H. L. Clark, B.M. No. 1958.7.30.19, Port Phillip, fig. 2 dorsal view, × 2/3, fig. 3 a denuded arm and part of the disc in dorsal view, × 2; figs. 4–6 *Nepanthia hadracantha* sp. nov., holotype, National Museum of Victoria, No. H14, fig. 4 dorsal and fig. 5 ventral views, × 2/3, fig. 6 detail of part of disc and two arm bases (one denuded), × 2

PLATE IV.

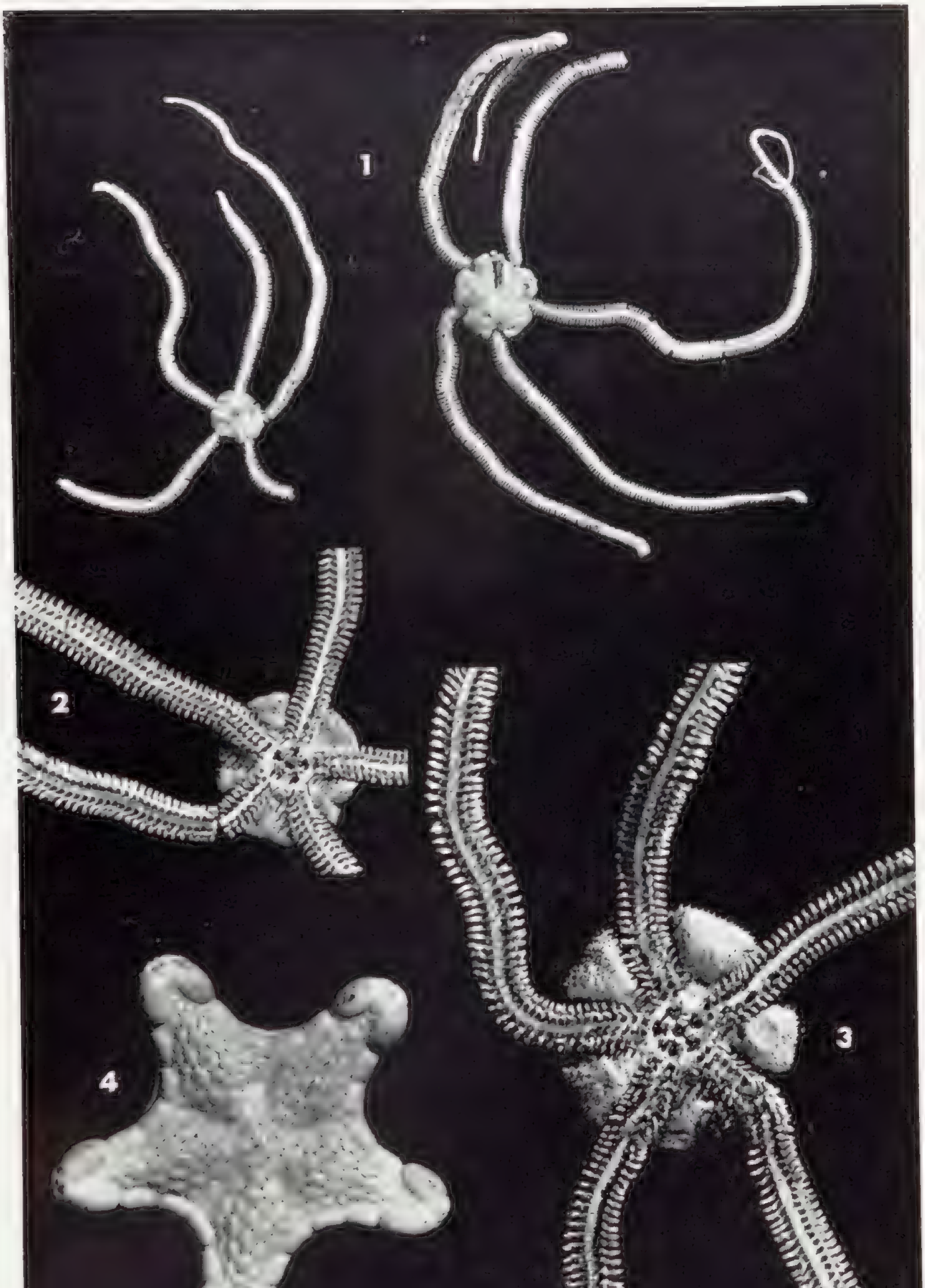

PLATE IV. Figs. 1–3 *Ophiocentrus pilosus* (Lyman). B.M. No. 1961.9.11.31 and 32, Corio Bay, Port Phillip, fig. 1 dorsal view, x 2/3, fig. 2 smaller and fig. 3 larger specimens in ventral view, both x 2; fig. 4 *Pentagonaster duebeni* Gray, B.M. No. 1962.4.9.8, Cape Schank, Victoria, dorsal view, x 2/3.

PORT PHILLIP SURVEY 1957–1963.

ASCIDIACEA.

By *R. H. MILLAR,*

Marine Station, Millport, Scotland.

SUMMARY.

An account is given of 38 species of ascidians in a collection from Port Phillip, Victoria. One of these is described as a new species *Ritterella asymmetrica.*

INTRODUCTION.

This paper deals with ascidians (subphylum Tunicata, class Ascidiacea) from Port Phillip collected during an ecological survey made by the National Museum of Victoria in collaboration with the Fisheries and Wildlife Department of Victoria. The treatment in the present paper is taxonomic, the ecological aspects being dealt with by other authors.

I wish to thank Miss J. Hope Macpherson of the National Museum of Victoria for providing the specimens and relevant information.

Positions of Areas and Stations are shown on Charts 1 and 2 (back of volume).

Chart 1 is a bathymetric chart plotted from Admiralty Chart 1171 Port Phillip with the numbered area grid superimposed.

Chart 2 shows the position of the stations numbered 1–317 with the same grid superimposed to aid in location of the stations and for correlation with depth, &c.

Localities in the text are shown as Area number followed immediately by the Station number in brackets. Table A (back of volume) records station number, date, method of collecting (dive or dredge) and depth in fathoms.

LIST OF SPECIES.

Order ENTEROGONA Perrier, 1898.

Suborder APLOUSOBRANCHIATA Lahille, 1886.

Family POLYCLINIDAE Verrill, 1871.

Aplidium phortax (Michaelsen).
Synoicum papilliferum (Michaelsen)?
Synoicum arenaceum (Michaelsen).
Ritterella asymmetrica sp. n.

Family CLAVELINIDAE Forbes and Hanley, 1848.

Clavelina baudinensis Kott.
Podoclavella cylindrica (Quoy and Gaimard).
Polycitor giganteus (Herdman).
Sycozoa tenuicaulis (Herdman).
Sycozoa cerebriformis (Quoy and Gaimard).
Distaplia viridis Kott.
Distaplia stylifera (Kowalevsky)?
Cystodites dellechiajei (Della Valle).

Suborder PHLEBOBRANCHIATA Lahille, 1886.

Family CIONIDAE Lahille, 1887.

Ciona intestinalis (Linnaeus).

Family CORELLIDAE Lahille, 1887.

Corella eumyota Traustedt.

Family PEROPHORIDAE Giard, 1872.

Perophora hutchisoni Macdonald.

Family ASCIDIIDAE Adams, 1858.

Ascidia sydneiensis Stimpson.
Ascidia gemmata Sluiter.
Ascidiella aspersa (Müller).

Order PLEUROGONA Perrier, 1898.

Suborder STOLIDOBRANCHIATA Lahille 1886.

Family STYELIDAE Sluiter, 1895.

Botryllus gracilis Hartmeyer and Michaelsen.
Botryllus stewartensis Brewin.
Botrylloides magnicoecus (Hartmeyer)?
Symplegma viride Herdman.
Amphicarpa diptycha (Hartmeyer).
Polyandrocarpa lapidosa (Herdman).
Oculinaria lapidosa Grey.
Polycarpa pedunculata Heller.
Styela etheridgii Herdman.
Styela plicata (Lesueur).
Asterocarpa cerea (Sluiter).

Family PYURIDAE Hartmeyer, 1908.

Pyura irregularis (Herdman).
Pyura pachydermatina (Herdman).
Pyura praeputialis (Heller).
Pyura fissa (Herdman).
Microcosmus spiniferus (Herdman).
Microcosmus australis Herdman.
Herdmania momus (Savigny).

Family MOLGULIDAE Lacaze-Duthiers, 1877.

Molgula sabulosa (Quoy and Gaimard).
Molgula janis Kott.

DESCRIPTION OF SPECIES.

FAMILY POLYCLINIDAE.

Aplidium phortax (Michaelsen).

Amaroucium phortax: Michaelsen, 1924, p. 389, figs. 20, 21.

MATERIAL.—Port Phillip Survey: Areas 18 (61); 55 (35); 56 (295); 59 (23–4).

Zooid.—The zooids agree closely with the description by Michaelsen (1924), particularly in the position of the pouch containing embryos, at the posterior end of the thorax (Fig. 1, A.). The specimens from Port Phillip have one or two embryos or larvae and Michaelsen noted one to three.

Larva (Fig. 1, B.). Kott (1963) described and figured larvae from Australian colonies that she identified as *A. phortax*, but these differ from larvae in specimens from Port Phillip as shown in Table 1.

TABLE 1.

	Kott (1963).	Port Phillip.
Length of trunk, mm	0·55 — 0·65	mean 0·9
Median papillae	absent	present

It appears that the Port Phillip specimens are not of the species described by Kott as *A. phortax*, but I believe that they do represent Michaelsen's species. In both cases the zooids agree quite well with the original account of *A. phortax*, which, unfortunately, did not include an adequate description of the larva. The ratio of depth to length of the larvae figured by Michaelsen, however, seems to agree better with the Port Phillip specimens than with Kott's specimens.

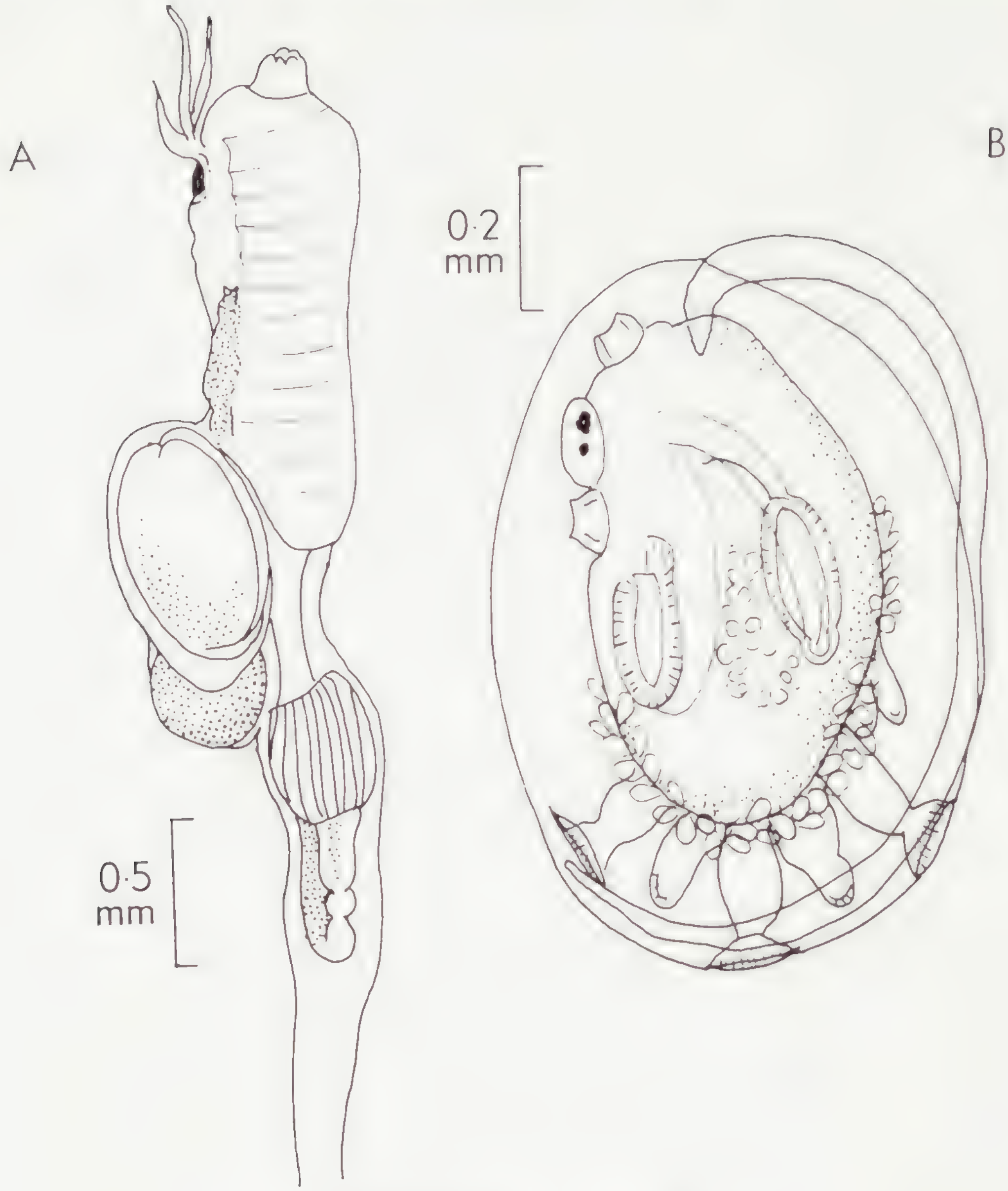

FIG. 1. *Aplidium phortax.* A, zooid. B, larva.

Synoicum papilliferum Michaelsen?

Synoicum papilliferum: Michaelsen, 1930, p. 530, fig. 7.

MATERIAL.—Port Phillip Survey: 59 (23–4).

REMARKS.—The present specimen lacks the small papilla below the atrial opening described by Michaelsen in the type specimen, but I can find no other difference. The identification remains doubtful, however, since good diagnostic characters are few in the genus, and *S. papilliferum* has been known hitherto only from Western Australia.

Synoicum arenaceum (Michaelsen).

Macroclinum arenaceum: Michaelsen, 1924, p. 406, figs. 23–25.

MATERIAL.—Port Phillip Survey: Area 69 (221).

REMARKS.—The colony consists of closely crowded upright columnar lobes flattened at their upper ends and united by a basal mass of common test. The stomach is either smooth externally or has indistinct longitudinal swellings or faint interrupted folds, but in transverse section it shows more distinct, broken folds (Fig. 2). The larval trunk is about 0·5 mm. long, and has three vertical papillae and numerous small lateral vesicles.

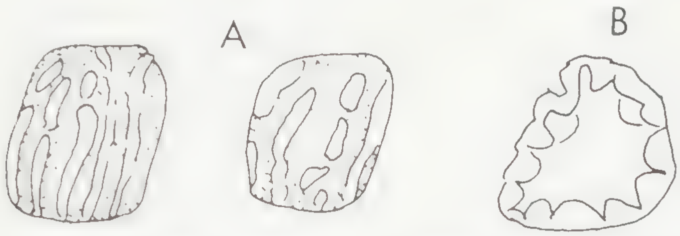

FIG. 2. *Synoicum arenaceum.* Stomach, from side (A), and in transverse section (B).

Ritterella asymmetrica sp. n.

MATERIAL.—Port Phillip Survey: Areas 58 (290); 59 (—); Holotype, National Museum, No. H 39.

Colony.—The colony consists of many slender club-shaped lobes, up to 4 cm. in length, arising from a common basal plate (Fig. 3A). The lobes are sometimes united in pairs near their lower ends or may have a branch or lateral lobe some distance from the apex. A characteristic is the expanded, somewhat spoon-shaped and asymmetrical upper end of the lobes, which has one flattened or slightly concave face and one convex face (Fig. 3B). A low, slightly scalloped ridge separates the two faces. Sand covers the whole surface of the colony, except on a series of small round areas on each face of the ridge. Each bare area on the concave face marks the position of the oral opening of a zooid, and an adjacent bare area on the convex face marks the position of the atrial opening of the same zooid. The zooids are therefore all orientated in the same way, with the ventral side towards the concave face of the expanded head of the lobe.

Zooid.—The zooids (Fig. 3C, D) reach 6 mm. or more in length. The thorax and abdomen are about the same length and the post-abdomen is often longer than their combined length. The oral siphon is terminal and the atrial siphon about one-third of the thoracic length from it. Both siphons usually have plain margins, but in a few zooids six indistinct lobes appear to be present on each siphon. The longitudinal muscles of the body wall are slender. Numerous oral tentacles of alternating sizes are present. Each of the ten rows has about 35 stigmata. There are no parastigmatic transverse bars. Stout triangular dorsal languets are present on the left branchial wall. A short oesophagus leads to the cylindrical or barrel-shaped stomach, which has about ten undivided folds. The

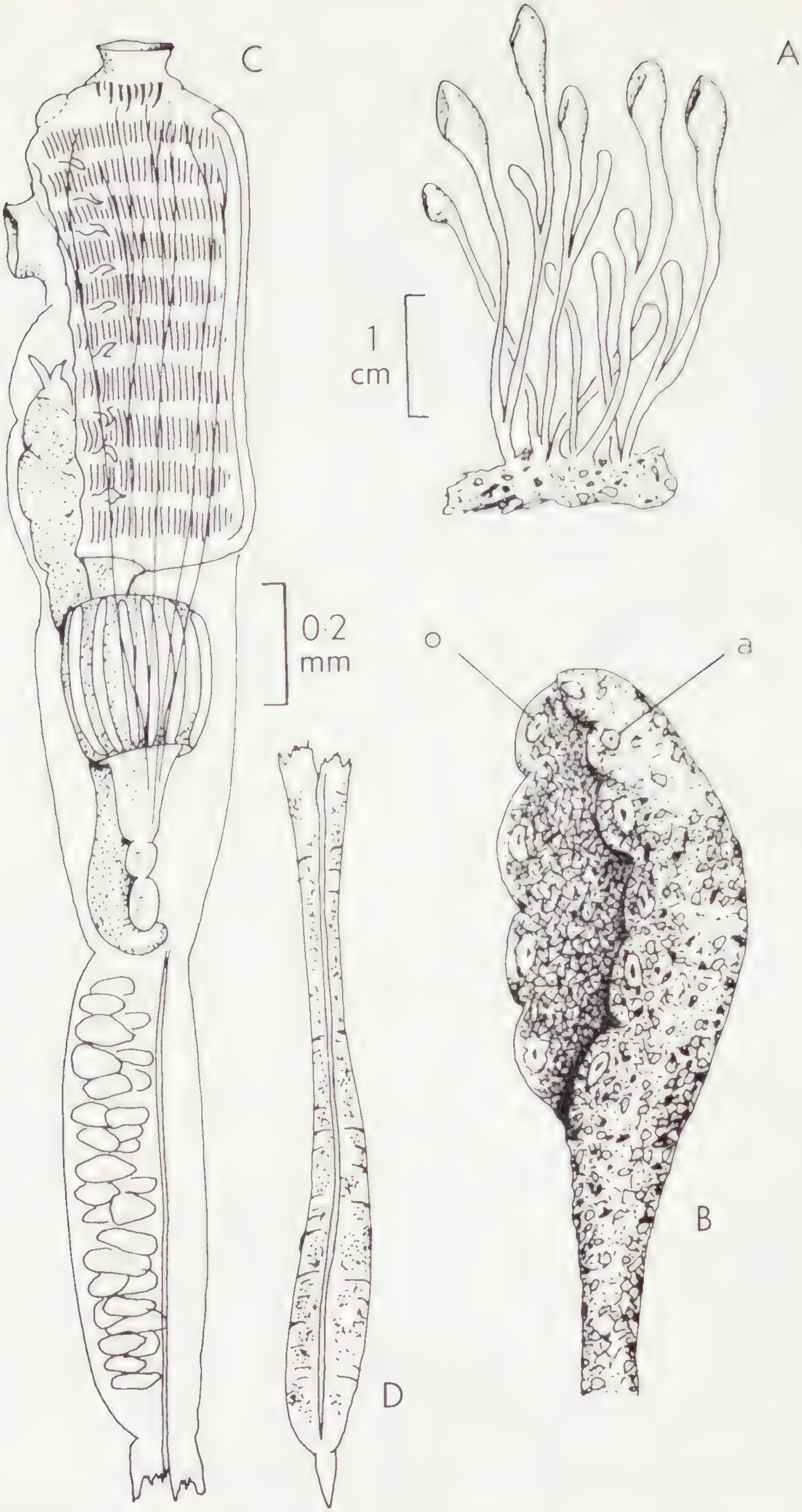

FIG. 3. *Ritterella asymmetrica.* A, colony. B, apex of lobe of colony (a, position of atrial siphon; o, position of oral opening). C, zooid, excluding posterior part, which is continued in D.

post-stomach and mid-gut are distinct, and the rectum ends in a two-lipped anus at the level of the fourth row of stigmata from the posterior end of the thorax. The testicular follicles are arranged along the upper half of the post-abdomen, the lower part of which is occupied by what appears to be storage tissue. The relative amounts of gonad and storage tissue may vary seasonally, as they do in polyclinid zooids.

REMARKS.—The colony of *Ritterella asymmetrica* resembles that of *R. herdmania* Kott (1957), which was originally described by Herdman (1899) as *Psammaplidium pedunculatum*. Differences between the two species are shown in Table 3.

TABLE 2.

	R. herdmania.	*R. asymmetrica.*
Apex of lobes	concave fan-shaped	spoon shaped
Oral openings	on convex surface	on concave surface
Atrial openings	on concave surface	on convex surface
Rows of stigmata	5	10
Folds on stomach	about 6	about 12

FAMILY CLAVELINIDAE.

Clavelina baudinensis Kott.

Clavelina baudinensis: Kott, 1957, p. 87, figs. 19–21.

MATERIAL.—Port Phillip Survey: Areas 6 (137); 59 (36).

Colony.—The specimen from Area 6 is a wedge-shaped colony, narrow at the base, where a number of root-like hairs of the test are developed. The colony is 2 cm. tall and 2 cm. wide across the top, and the zooids can be seen through the translucent test. This specimen therefore differs somewhat from Kott's specimens. The colony from Area 59 is more typical in shape.

Zooid.—The only feature in which these zooids differ from Kott's type material appears to be the presence of dark-blue pigment on the body wall over the anterior end of the endostyle, round the ganglion, on the dorsal side of the base of the atrial siphon, and over the anus. The anal border, which was not described by Kott, has eight small rounded lobes.

REMARKS.—The previous records of this species are from Western Australia and Victoria.

Podoclavella cylindrica (Quoy and Gaimard).

Polyclinum cylindricum: Quoy and Gaimard, 1834, p. 618. For synonymy see Michaelsen, 1930, p. 475.

MATERIAL.—Port Phillip Survey: Area 59 (36).

Zooid.—Kott (1957) distinguished between *P. cylindrica* (Quoy and Gaimard) with 21 rows and *P. australis* Kott with ten rows of stigmata. The present material is intermediate, having about thirteen rows, and I have already suggested that the species are synonymous (Millar, 1960).

Brood pouch (Fig. 4).—A conspicuous brood pouch is present on the right side, at the base of the thorax, on most zooids. It is apparently the expanded terminal part of the oviduct, and opens by an oval slit into the right peribranchial cavity. Many developing embryos are contained in the pouches.

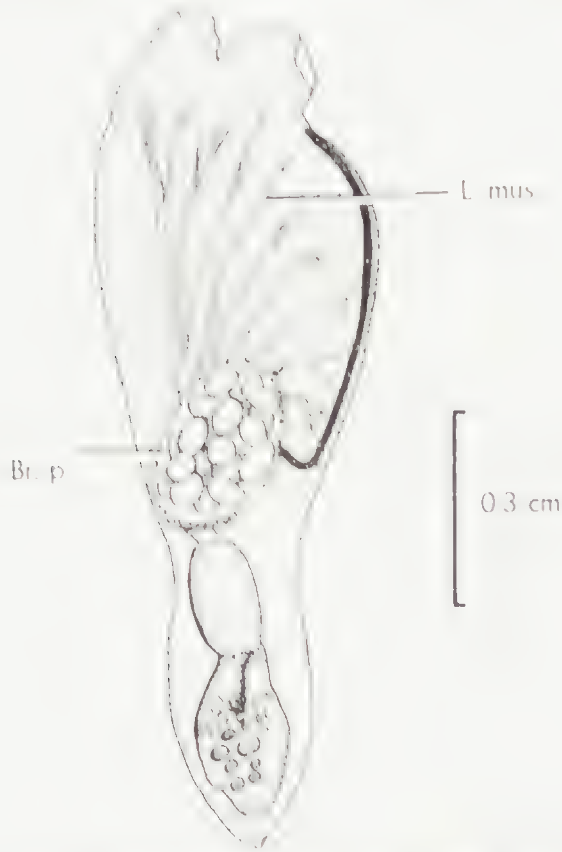

FIG. 4. *Podoclavella cylindrica.* Zooid with test removed, to show brood pouch. Br. p., brood pouch containing embryos. L. mus., longitudinal muscles.

Polycitor giganteus (Herdman).

Polyclinum giganteum: Herdman, 1899, p. 79, figs. 1, 2. Pl. Pel II.

MATERIAL.—Port Phillip Survey: Areas 55 (39); 61 (37); 67 (216).

REMARKS.—The specimens, which are quite typical of the species, contained larvae when collected on 10.XI.1957 and 8.XII.1957.

Sycozoa tenuicaulis (Herdman).

Colella tenuicaulis: Herdman, 1899, p. 64, Pl. Dist, I, figs. 1–16.

MATERIAL.—Port Phillip Survey: Areas 6 (67); 7 (123); 9 (62); 10 (12); 12 (111); 19 (306); 20 (309); 23 (7); 26 (126); 33 (177); 35 (73, 75); 36 (75); 38 (311); 40 (102); 43 (303); 47 (29).

REMARKS.—The species has been well described by Herdman (1899) and Brewin (1953), and is already recorded from Port Phillip (Herdman, 1899; Kott, 1957).

Sycozoa cerebriformis (Quoy and Gaimard)

Aplidie cerebriforme: Quoy and Gaimard, 1834, p. 625, figs. 16, 17.

MATERIAL.—Port Phillip Survey: Areas 58 (150–4); 59 (36); 66 (291–2).

Distaplia viridis Kott.

Distaplia viridis: Kott, 1957, p. 96, figs. 28–30.

MATERIAL.—Port Phillip Survey: Area 61 (37).

REMARKS.—The single specimen agrees well with Kott's description and, like her material, show no ovary but only a rosette of testis follicles beside the intestinal loop. The larvae measure about 1·0 mm. from the end of the papillae to the base of the tail.

Kott, (1957) noted that this species resembles *D. domuncula* Michaelsen from South Africa, but considered it to be probably separate. The gonads clearly distinguish the two species; they are contained in a sac below the abdomen in *D. domuncula* (Michaelsen, 1923; Millar, 1955) but are beside the intestinal loop in *D. viridis*.

Distaplia stylifera (Kowalevsky)?

Didemnium styliferum: Kowalevsky, 1874, p. 443, pl. 30, figs. 1–16.

MATERIAL.—Port Phillip Survey: Areas 10 (12); 22 (119); 23 (68).

Colony.—The colonies are club-shaped rather than mushroom-shaped as in the well developed specimens described by Van Name (1945). Each head has several systems of zooids, each system with its own common cloacal opening.

REMARKS.—I have some doubt whether these specimens belong to *D. stylifera* or to *D. australensis* Brewin. Brewin (1953) uses four distinguishing characters: (1) the arrangement of zooids in systems, (2) the number of stigmata per row (3) the nature of the brood pouches, and (4) the geographical distribution. Distribution is not a good specific character, the number of stigmata per row is very variable in *D. stylifera* (Brewin, 1953) and no brood pouches are developed in the present material, so identification as *D. stylifera* rests mainly on the systems of zooids.

Cystodites dellechiajei (Della Valle).

Distoma dellechiajei: Della Valle, 1877, p. 40.

MATERIAL.—Port Phillip Survey: Area 56 (295).

FAMILY CIONIDAE.

Ciona intestinalis (Linnaeus).

Ascidia intestinalis: Linnaeus, 1767, vol. 1, pp. 2, 1087.

MATERIAL.—Port Phillip Survey: Area 37 (40).

FAMILY CORELLIDAE.

Corella eumyota Traustedt.

Corella eumyota: Traustedt, 1882, p. 271, pl. 4, figs. 2, 3; pl. 5, figs. 13, 14.

MATERIAL.—Port Phillip Survey: Area 42 (38).

FAMILY PEROPHORIDAE.

Perophora hutchisoni Macdonald

Perophora hutchisoni: Macdonald, 1859, p. 377, pl. 65, II, figs. 1–3.

MATERIAL.—Port Phillip Survey: Area 59 (79).

Colony.—These specimens, some of which are growing on the fronds on an alga, closely resemble the type specimens illustrated by Macdonald (1859), and, like them, are heavily coated with sand grains.

REMARKS.—The only records of the species are from Fremantle and Albany and from Stewart Island, New Zealand if *P. boltenia* Michaelsen is a synonym, as suggested by Michaelsen and Hartmeyer (1928).

FAMILY ASCIDIIDAE.

Ascidia sydneiensis Stimpson.

Ascidia sydneiensis: Stimpson, 1885, p. 387.

MATERIAL.—Port Phillip Survey: Area 59 (23–4).

REMARKS.—The specimen has a much-convoluted slit of the dorsal tubercle and an accumulation of mud in the gut, both characters commonly found in the species.

Ascidia gemmata Sluiter.

Ascidia gemmata: Sluiter, 1895, p. 177, pl. 9, figs. 7–9.

MATERIAL.—Port Phillip Survey: Areas 5 (57); 6 (66, 137); 7 (123); 21 (176); 22 (119); 23 (7, 69–70); 27 (41); 31 (131); 33 (177); 43 (274); 52 (252); 64 (163); 67 (216).

REMARKS.—The shape of the body and the gut vary somewhat, as indicated in Fig. 5, but the rather soft greenish-grey test and the simple U-shaped slit of the dorsal tubercle help to identify the species, in addition to the closely set papillae of the prebranchial zone which Kott (1952) also found.

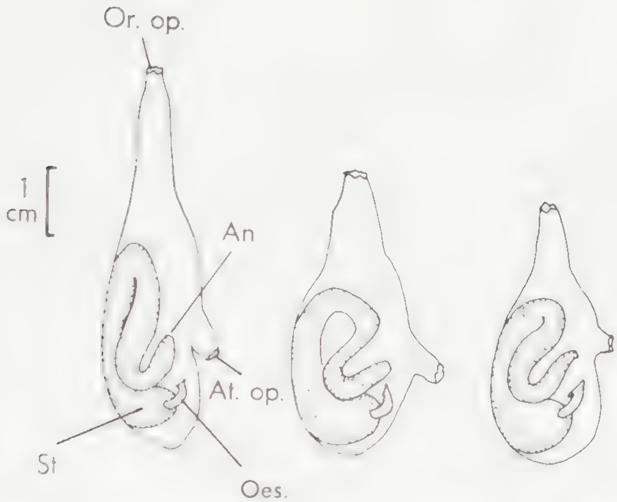

FIG. 5. *Ascidia gemmata.* Three specimens with test removed, to show variation in shape of body and gut. An., anus. At. op., atrial opening. Oes., oesophagus st., stomach.

Ascidiella aspersa (Müller).

Ascidia aspersa: Müller, 1876, p. 225.

MATERIAL.—Port Phillip Survey: Areas 12 (111–3, 198); 22 (119); 23 (70–1); 32 (277); 33 (177); 35 (72, 121); 37 (40, 296); 55 (22).

FAMILY STYELIDAE.

Botryllus gracilis Hartmeyer and Michaelsen.

Botryllus gracilis: Hartmeyer and Michaelson, 1928, p. 338, fig. 22.

MATERIAL.—Port Phillip Survey: Area 6 (118).

Colony.—The single colony, which had been growing on the shell of a living mussel, is very thin and almost transparent. In the alcohol-preserved material the zooids are pale grey.

Zooid.—The zooids are as described by Hartmeyer and Michaelsen (1928) except that in the present material short tubular oral siphons are developed whereas the type specimens had sessile branchial openings.

Larva.—Larvae, numbering one or two, are present in the atrial cavity of many of the zooids, and are of the type common in the subfamily Botryllinae. There is a single black sense organ, a ring of ampullae round the anterior end of the trunk, and three anterior papillae. The trunk is about 0·44 mm. long.

REMARKS.—Neither the type nor the present material had gonads sufficiently well developed to show whether the species is a *Botryllus* or a *Botrylloides*, but, like Hartmeyer and Michaelsen (1928), I believe it to be a *Botryllus*.

This species has been recorded hitherto only from Sharks Bay, Western Australia.

Botryllus stewartensis Brewin.

Botryllus stewartensis: Brewin, 1958, p. 447, figs. 3 A_1, A_2, A_3, A_5, A_6, A_7.

MATERIAL.—Port Phillip Survey: Area 51 (250).

Colony.—The dome-shaped mass is 10 cm. in diameter and consists of closely crowded upright columnar lobes each with an expanded end the centre of which forms a shallow depression. The lobes converge at their lower ends and join a narrow irregular mass of test which constitutes a short stalk.

REMARKS.—This is a much more massive specimen than the type material, but the arrangement and structure of the zooids are similar, and in particular the shape of the lobes and the coating of sand are such unusual features in the family that identification is almost certain.

Botrylloides magnicoecus (Hartmeyer)?

Botrylloides nigrum: Herdman var. *magnicoecum*: Hartmeyer, 1913, p. 135.

MATERIAL.—Port Phillip Survey: Area 18 (61): Flinder's Jetty.

Colony.—The colonies are of the kind described by Kott (1952), and consist of long fleshy lobes, the basal parts of which are devoid of zooids. The narrow systems of zooids are parallel to the long axis of the lobes.

REMARKS.—The records of this species accepted by Hartmeyer and Michaelsen (1928) include specimens from Western Australia, China, India, East Africa, South Africa, and possibly Europe. It would not be surprising if some of the records referred to other species, particularly since specific characters in *Botryllus* and *Botrylloides* are not entirely satisfactory. I am therefore identifying the present material as *B. magnicoecus* only provisionally.

Symplegma viride Herdman.

Symplegma viride: Herdman, 1886, p. 144, pl. 18, figs. 7–14.

MATERIAL.—Port Phillip Survey: Area 6 (137).

REMARKS.—This species is already known from Queensland, South Australia and Western Australia.

Amphicarpa diptycha (Hartmeyer).

Distomus diptychos: Hartmeyer, 1919, p. 87, pl. 2, fig. 48.

MATERIAL.—Port Phillip Survey: Areas 42 (38); 59 (23–4, 36).

REMARKS.—The specimens agree better with *A. diptycha* (Hartmeyer) than with *A. elongata* Kott, but the distinctions between these two related species are not very marked.

Polyandrocarpa lapidosa (Herdman).

Goodsiria lapidosa: Herdman, 1899, p. 99, pl. Pst. III, figs. 1–12.

MATERIAL.—Port Phillip Survey: Areas 60 (235); 67 (216).

Colony.—The largest colony collected is 10 by 7 by 5 cm. Sand grains are present not only on the surface as in the specimens described by Herdman (1899) and Kott (1952), but also throughout the depth of the test.

Zoöid.—The body wall is delicate and pink, and the siphons short or moderately long. Herdman and Kott both noted the irregularity of the branchial stigmata, but the present specimens show quite regular stigmata. The slit of the dorsal tubercle is almost straight and transverse, or crescentic with the open interval facing posteriorly. The anal border, which Kott found to be smooth, is indented to form numerous shallow rounded lobes, in the Port Phillip specimens.

REMARKS.—The similarity between *P. lapidosa* and the South African *P. anguinea* (Sluiter) has been noted (Millar, 1963). In both species the large zooids are closely crowded to form a hard compact colony incrusted or impregnated with sand grains, and the long narrow branchial sac has a similar arrangement of folds and bars, but the shape and alignment of the stomach differ, and the form of the dorsal tubercle (Fig. 6).

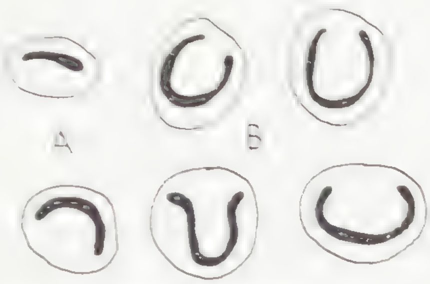

FIG. 6. Dorsal tubercles of A, two specimens of *Polyandrocarpa lapidosa* and B, four specimens of *P. anguinea.*

P. anguinea was originally described as a solitary ascidian in the genus *Styela*, and although budding has not been observed in either that species or *P. lapidosa* there can be little doubt that they are colonial species of the genus *Polyandrocarpa.*

Oculinaria australis Gray.

Oculinaria australis: Gray, 1868, p. 564, 1 fig.

MATERIAL.—Port Phillip Survey: Area 56 (295).

REMARKS.—This very distinctive species has previously been recorded only on the west coast of Australia.

Polycarpa pedunculata Heller.

Polycarpa pedunculata: Heller, 1878, p. 106, pl. 6, fig. 30.

MATERIAL.—Port Phillip Survey: Areas 6 (65); 7 (123); 9 (62); 18 (59); 25 (129); 26 (126); 27 (302); 28 (140); 29 (107); 38 (127); 39 (42); 59 (24).

REMARKS.—Some specimens have a wide base and others a narrow base, but none has a definite stalk like that of the type specimen. In other respects, however, there is good agreement with the description by Heller

(1878) and Michaelsen (1905). The distinctions between *P. pedunculata* and *P. stephenensis* Herdman are not satisfactory. The stalk is probably a variable character. *P. pedunculata* has about 200 small gonads grouped in areas into which the inner surface of the body wall is divided, and *P. stephenensis* has not more than 100 gonads, which are comparatively large, and not grouped. I have already found some specimens (Millar, 1963) agreeing well with *P. stephenensis* and others from Fremantle with gonads which numbered only 30–40, as in *P. pedunculata* but which were grouped in separate areas as in *P. stephenensis*. It may be that only one species is involved, which varies considerably.

Styela etheridgii Herdman.

Styela etheridgii: Herdman, 1899, p. 38, pl. Cyn. XIII, figs. 1–8.

MATERIAL.—Port Phillip Survey: Areas 5 (57); 6 (65); 10 (11–4); 11 (212); 12 (111); 18 (59); 19 (305); 32 (277); 39 (48); 55 (148); 63 (159).

REMARKS.—This is a variable species, as shown by Kott (1952), and the specimens from Port Phillip all fall within the normal range of variation.

Styela plicata (Lesueur).

Ascidia plicata: Lesueur, 1823, p. 5, pl. 3, fig. b.

MATERIAL.—Port Phillip Survey: Areas 5 (165–6); 17 (170); 18 (59); 26 (301); 27 (41); 28 (140); 31 (10, 131–4); 37 (40); 39 (43).

Asterocarpa cerea (Sluiter).

Styela cerea: Sluiter, 1900, p. 24, pl. III, figs. 9–11.

MATERIAL.—Port Phillip Survey: Areas 22 (119); 23 (68–70).

Gonads.—The gonads are the most characteristic feature of this species, and are well developed in the present specimens, one of which shows, on the left, a single group of two *Cnemidocarpa*-type gonads, and on the right, four or five groups each of 2–4 gonads. Most of the gonoducts point in a ventral direction.

REMARKS.—The relationships and synonymy of this species have been discussed in detail by Hartmeyer (1927) and Brewin (1946). It appears that there is either one species widely distributed in southern waters, or a group of similar species. A number of these species, including possibly *A. cerea*, differ only slightly from typical species of *Cnemidocarpa*, and I am not certain that generic separation is necessary.

FAMILY PYURIDAE.

Pyura irregularis (Herdman).

Cynthia irregularis: Herdman, 1882, p. 141, pl. XVI, figs. 10–12.

MATERIAL.—Port Phillip Survey: Areas 5 (166); 9 (179–180); 18 (59); 19 (181); 31 (131).

Dorsal tubercle.—The dorsal tubercle (Fig. 7), as in Kott's (1952) description, has anterior blister-like pads and a simple U-shaped slit contained in a long narrow peritubercular area.

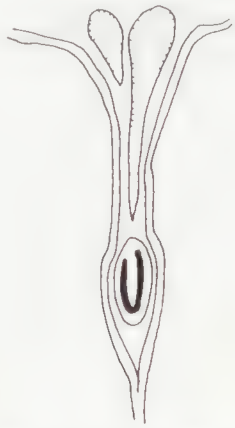

FIG. 7. *Pyura irregularis.* Dorsal tubercle and associated pads.

Pyura pachydermatina (Herdman).

Boltenia pachydermatina: Herdman, 1881, p. 81.

MATERIAL.—Port Phillip Survey: Areas 42 (108); 52 (252); 56 (295); 58 (151); 59 (24, 36).

REMARKS.—This species has been divided into a number of varieties. The present specimens agree with var. *gibbosa* Herdman in the structure of the anal border (Fig. 8), which is one of the few distinguishing characters.

FIG. 8. *Pyura pachydermatina.* Part of anal border.

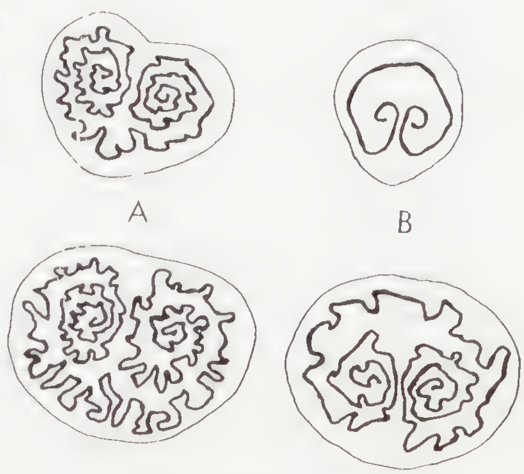

FIG. 9. Dorsal tubercles of A, two specimens of *Pyura praeputialis* from Port Phillip and B, two specimens of *Pyura stolonifera* from South Africa.

Pyura praeputialis (Heller).

Cynthia praeputialis: Heller, 1878, p. 94, pl. III, fig. 16, pl. IV, fig. 22.

MATERIAL.—Port Phillip Survey: Areas 2 (201); 5 (166–8); 9 (178–180); 10 (11–5); 11 (125, 191–2); 26 (126); 28 (140); 30 (10); 39 (312–4); 42 (108, 265, 288); 47 (29); 59 (24, 36); 63 (159–62); 64 (163); 67 (216).

REMARKS.—Heller described two similar species, *Cynthia stolonifera* from South Africa, and *Cynthia praeputialis* from Australia. These are species of *Pyura* that have been considered identical (Kott, 1952), although Kott admits that " the nomenclature of the group is still very confused ".

P. stolonifera and *P. praeputialis* appear to be distinguishable as shown in Table 4.

TABLE 3.

—	*P. stolonifera.*	*P. praeputialis.*
Body form	Short finger-like test processes round siphons and anterior body. Usually no anterior body depression.	No anterior processes. Marked anterior body depression round siphons.
Dorsal tubercle	Basically C-shaped with open interval posterior.	Basically C-shaped with open interval anterior.

These distinctions are based on a comparison that I have made of numerous South African specimens with material from Port Phillip and from New South Wales [British Museum (Nat. Hist.) specimens]. In both species the pattern of the slit of the dorsal tubercle becomes very complex in large specimens, but small specimens show the basic form (Fig. 9). The Australian material invariably has the open interval of the slit anterior. In most South African specimens the open interval is posterior, and I have seen only one in which it is lateral and two anterior. Although Heller's original account of *P. stolonifera* does not clarify the point, Hartmeyer (1911) re-examined the type specimens and his fig. 9, plate 57, clearly shows the open interval posterior. The same pattern is seen in Hartmeyer's fig. 10, plate 57, of a South African specimen from the German South-polar Expedition of 1901–03. Hartmeyer noted the presence of a rudimentary seventh branchial fold in *P. stolonifera*, contrasting with the six folds always present in *P. praeputialis*. He therefore concluded that the two species are closely related but separate, a finding with which I agree.

Pyura fissa (Herdman).

Cynthia fissa: Herdman, 1881, p. 58.

MATERIAL.—Port Phillip Survey: Areas 31 (10); 35 (73).

REMARKS.—This species does not appear to have been recorded since Herdman described it from Bass Strait. Its distinguishing characters,

shown by the type material and confirmed by the specimens from Port Phillip, are (1) the external form as illustrated by Herdman, (2) the oral tentacles, which have short primary branches, some having short secondary branches but many with none (Fig. 10), (3) the simple dorsal tubercle with one or both horns turned outwards, and (4) the six branchial folds on each side.

FIG. 10. *Pyura fissa.*
Oral tentacle.

Microcosmus spiniferus (Herdman).

Cynthia spinifera: Herdman, 1899, p. 32, pl. Cyn. X, figs. 1–12.

MATERIAL.—Port Phillip Survey: Areas 6 (63–4, 137); 19 (181); 21 (176); 23 (70); 28 (141); 31 (132); 35 (121); 63 (159–62); 64 (163); 69 (100).

REMARKS.—Herdman (1899) and Kott (1952) described the dorsal lamina as smooth, but the material from Port Phillip always has a toothed edge to the lamina, which, however, is sometimes rolled over in such a way as to hide the teeth.

Microcosmus australis Herdman.

Microcosmus australis: Herdman, 1899, p. 23, pl. Cyn. V.

MATERIAL.—Port Phillip Survey: Areas 5 (57, 165–9); 6 (118, 137); 7 (123); 11 (190); 14 (175); 23 (70); 35 (121); 42 (38, 108, 265); 47 (29); 62 (99).

REMARKS.—The relationships between *Microcosmus claudicans* (Savigny), *M. exasperatus* Heller and *M. australis* Herdman are uncertain. Hartmeyer and Michaelsen (1928) divided *M. claudicans* into four subspecies: *typicus*, *exasperatus*, *australis* and *squamiger*, of which the last three occur on various parts of the Australian coast. Kott (1952) recognized a variety *australis* of the species *M. claudicans*. I do not have sufficient material from other regions for comparison, but prefer to adopt Herdman's species *M. australis* for the Port Phillip specimens.

Kott (1952) described three gonads on the left and four on the right, although Herdman (1899) referred to one on each side. I find only one gonad on each side, but it is broken up into three or four masses united by a common oviduct and sperm duct.

Herdmania momus (Savigny).

Cynthia momus: Savigny, 1816, p. 143, pl. 1, fig 2, pl. 4, fig. 1.

MATERIAL.—Port Phillip Survey: Areas, 12 (198); 31 (10); 58 (151); 59 (24, 36); 61 (37); 66 (291–2); 67 (216).

REMARKS.—Hartmeyer and Michaelsen (1928) and Kott (1952) recognized several varieties or forms of this species but the specimens from Port Phillip Bay do not indicate whether or not the subdivision is justified.

FAMILY MOLGULIDAE.

Molgula sabulosa (Quoy and Gaimard).

Ascidia sabulosa: Quoy and Gaimard, 1834, p. 613, pl. XCI. figs. 19–22.

MATERIAL.—Port Phillip Survey: Areas 9 (84); 10 (13, 15); 18 (60); 27 (284); 37 (40); 50 (266); 51 (270).

REMARKS.—*M. sabulosa* and *M. pedunculata* Herdman have been regarded as identical (Kott, 1952), but, as I have shown (Millar, 1960) there are constant differences in the dorsal tubercle and gonad. *M. pedunculata* is an Antarctic and *M. sabulosa* an Australian species.

Molgula janis Kott.

Molgula janis: Kott, 1952, p. 295, fig. 158.

MATERIAL.—Port Phillip Survey: Area 60 (235).

REMARKS.—The larger of the two specimens has a greatest diameter of 1·5 cm. In most respects these specimens agree well with Kott's description, but differ in the following features: (1) the absence of flap-like extensions of the test and body wall round the siphons; (2) a maximum of five longitudinal bars on some branchial folds and the presence of at least one bar on the dorsal face of some folds.

These differences appear much less important than the similarities, and in particular the ring-shaped testis and the general branchial structure, which are characteristic of *M. janis*. A strand of connective tissue passes from the branchial wall to the body wall through the central opening of the testis (Fig. 11.)

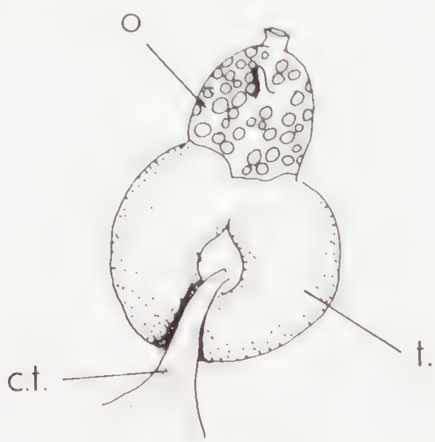

FIG. 11. *Molgula janis*, Gonad. O, ovary, t, testes, c.t., connective tissue.

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TABLE A.

Number for each station where material was collected, with date, area number, dive or dredge number and water depth.

Station Number.	Date.	Area.	Dive Dredge D. Dr.	Depth (fms).
1	26.5.57	23	D. 1	$4\frac{3}{4}$
2	..	23	D. 2	$4\frac{3}{4}$
3	..	23	D. 3	$4\frac{1}{4}$
4	..	14	D. 4	4
5	..	14	D. 5	$3\frac{1}{4}$
6	..	23	D. 6	$4\frac{3}{4}$
7	..	23	D. 7	$4\frac{3}{4}$
8	..	14	D. 8	$3\frac{1}{2}$
9	,,	23	D. 9	$5\frac{1}{4}$
10	16.6.57	31	D. 1	$5\frac{1}{4}$
	11.9.60	31	D. 1	$5\frac{1}{4}$
11	23.6.57	10	D. 1	$8\frac{1}{2}$
12	..	10	D. 2	8
13	..	10	D. 3	7
14	..	10	D. 4	7
15	..	10	D. 5	4
16	14.7.57	63	D. 1	4
17	..	63	D. 2	$3\frac{1}{2}$
18	..	63	D. 3	3
19	..	63	D. 4	$2\frac{1}{2}$
20	..	63	D. 5	$2\frac{1}{2}$
21	..	63	D. 6	$2\frac{1}{2}$
22	..	55	D. 7	$4\frac{1}{2}$
23	15.9.57	59	D. 1	$2\frac{1}{2}$
24	..	59	D. 2	$1\frac{1}{2}$
25	,,	59	D. 3	$2\frac{1}{2}$
26	13.10.57	47	D. 1	9
27	..	47	D. 2	$8\frac{1}{2}$
28	,,	47	D. 3	$8\frac{1}{4}$
29	..	47	D. 4	5
30	..	47	D. 5	3
31	,,	47	D. 6	3
32	,,	48	D. 7	$2\frac{1}{2}$
33	..	48	D. 8	2
34	,,	48	D. 9	$1\frac{1}{2}$
35	,,	55	D. 10	$3\frac{1}{2}$
36	10.11.57	59	D. 1	5
	,,	59	Intertidal	collection

TABLE A.—*continued.*

Station Number.	Date.	Area.	Dive D. Dredge Dr.	Depth (fms).
36	7.4.59	59	D. 1	3
	21.2.60	59	D. 1	6
	16.4.61	59	D. 1	3
	5.5.63	59	D. 1	2
37	8.12.57	61	D. 1	4
38	13.1.58	42	Intertidal and near-shore	collection diving
39	19.1.58	55	D. 1	2
40	16.2.58	37	D. 1	2
41	,,	27	D. 1	$1\frac{1}{2}$
42	9.3.58	39	D. 1	$1\frac{1}{4}$
43	,,	39	D. 2	$2\frac{1}{2}$
44	,,	39	D. 3	$3\frac{1}{2}$
45	,,	39	D. 4	$3\frac{1}{2}$
46	,,	39	D. 5	3
47	,,	39	D. 6	3
48	,,	39	D. 7	3
49	,,	27	D. 8	6
50	,,	27	D. 9	5
51	20.4.58	5	D. 1	4
52	,,	5	D. 2	3
53	,,	5	D. 3	3
54	,,	5	D. 4	$2\frac{1}{2}$
55	,,	5	D. 5	3
56	,,	5	D. 6	3
57	,,	5	D. 7	2
58	,,	5	D. 8	2
59	18.5.58	18	D. 1	6
60	,,	18	D. 2	$4\frac{1}{2}$
61	,,	18	D. 3	$3\frac{1}{2}$
62	,,	9	D. 4	$2\frac{1}{2}$
63	29.6.58	6	D. 1	$6\frac{1}{4}$
64	,,	6	D. 2	5
65	,,	6	D. 3	5
66	,,	6	D. 4	$4\frac{1}{2}$
67	,,	6	D. 5	$4\frac{1}{2}$
68	14.12.58	23	D. 1	$8\frac{1}{2}$
69	,,	23	D. 2	8
70	,,	23	D. 3	9
71	,,	35	D. 4	11
72	,,	35	D. 5	9

TABLE A.—*continued.*

Station Number.	Date.	Area.	Dive D. Dredge Dr.	Depth (fms).
73	14.12.58	35	D. 6	9
74	,,	36	D. 7	8
75	,,	36	D. 8	8
76	,,	36	D. 9	5
77	,,	36	D. 10	4
78	,,	36	D. 11	4
79	18.1.59	59	D. 1	2
80	,,	58	D. 2	$2\frac{1}{2}$
81	,,	58	D. 3	2
82	8.3.59	13	D. 1	4
83	,,	13	D. 2	6
84	28.3.59	9	Intertidal	collection
85	7.4.59	60	Dr.1	6
86	,,	60	Dr.2	11
87	,,	59	Dr.1	$7\frac{1}{2}$
88	,,	58	Dr.1	7
89	8.4.59	58	Intertidal	collection
90	,,	58	Dr.1	6
91	,,	58	Dr.2	6
92	19.4.59	13	D. 1	4
93	,,	13	D. 2	2
94	,,	13	D. 3	2
95	,,	14	D. 4	$1\frac{3}{4}$
96	10.5.59	62	D. 1	6
97	,,	69	D. 2	$6\frac{1}{2}$
98	,,	62	D. 3	6
99	,,	62	D. 4 ; Dr.1	6
100	,,	69	D. 5	3
101	21.6.59	40	D. 1	1
102	,,	40	Dr.1	5
103	12.7.59	10	D. 1	$2\frac{1}{4}$
104	,,	10	D. 2	$2\frac{1}{2}$
105	,,	10	D. 3	$2\frac{1}{2}$
106	,,	10	D. 4	$2\frac{1}{2}$
107	9.8.59	29	D. 1	$2\frac{1}{2}$
108	,,	42	D. 2	2
109	,,	42	D. 3	$2\frac{1}{2}$
110	18.10.59	12	D. 1	$8\frac{1}{2}$
111	,,	12	D. 2	9
112	,,	12	D. 3	9
113	,,	12	D. 4	10

TABLE A.—*continued.*

Station Number.	Date.	Area.	Dive D. Dredge Dr.	Depth (fms).
114	15.11.59	12	D. 1	10
115	,,	21	D. 2	10
116	,,	14	D. 3	3
117	,,	14	D. 4	2
118	17.1.60	6	D. 1	$\frac{3}{4}$
119	10.4.60	22	D. 1	$11\frac{1}{2}$
120	,,	34	D. 2	11
121	,,	35	D. 3	11
122	,,	24	D. 4	4
123	22.5.60	7	D. 1	$3\frac{1}{2}$
124	,,	20	D. 2	12
125	,,	11	D. 3	8
126	14.8.60	26	D. 1	$3\frac{1}{2}$
127	,,	38	D. 2	5
128	,,	25	D. 3	5
129	,,	25	D. 4	2
130	11.9.60	30	D. 2	6
131	,,	31	D. 3	8
132	,,	31	D. 4	$8\frac{1}{2}$
133	,,	31	D. 5	$9\frac{1}{2}$
134	,,	31	D. 6	$9\frac{1}{2}$
135	,,	30	D. 7	2
136	16.10.60	6	D. 1	$1\frac{1}{2}$
137	15.1.61	6	D. 1	$2\frac{1}{2}$
138	22.1.61	27	D. 1	$2\frac{1}{2}$
139	,,	27	D. 2	$1\frac{1}{2}$
140	,,	28	D. 3	3
141	,,	28	D. 4	$3\frac{1}{2}$
142	,,	16	D. 5	3
143	,,	16	D. 6	$3\frac{1}{2}$
144	26.2.61	55	D. 1	10
145	,,	55	D. 2	$8\frac{3}{4}$
146	,,	55	D. 3	8
147	,,	55	D. 4	$5\frac{1}{2}$
148	,,	55	D. 5	$3\frac{1}{2}$
149	,,	55	D. 6	$2\frac{1}{2}$
150	21.5.61	58	D. 1	3
151	,,	58	D. 2	$3\frac{1}{2}$
152	,,	58	D. 3	$3\frac{1}{2}$
153	,,	58	D. 4	$6\frac{1}{2}$
154	,,	58	D. 5	5

TABLE A.—*continued.*

Station Number.	Date.	Area.	Dive Dredge D. Dr.	Depth (fms).
155	25.6.61	68	D. 1	$5\frac{1}{2}$
156	,,	68	D. 2	$7\frac{1}{2}$
157	,,	68	D. 3	6
	,,	68	D. 4	6
158	,,	68	D. 5	8
159	20.8.61	63	D. 1	10
160	,,	63	D. 2	5
161	,,	63	D. 3	4
162	,,	63	D. 4	$3\frac{1}{2}$
163	,,	64	D. 5	2
164	,,	64	D. 6	$1\frac{1}{2}$
165	26.10.61	5	D. 1	5
166	,,	5	D. 2	7
167	,,	5	D. 3	7
168	,,	5	D. 4	$1\frac{1}{2}$
169	,,	5	D. 5	3
170	12.11.61	17	D. 1	$5\frac{1}{2}$
171	,,	17	D. 2	$4\frac{1}{2}$
172	,,	17	D. 3	3
173	,,	17	D. 4	2
174	,,	29	D. 5	$6\frac{1}{4}$
175	18.12.62	14	D. 1	$2\frac{1}{2}$
176	19.12.62	21	D. 1	12
177	,,	33	D. 2	12
178	20.3.63	9	D. 1	$1\frac{1}{2}$
179	,,	19	D. 2	$3\frac{1}{2}$
180	,,	9	Dr.1	3
181	,,	19	Dr.2	$3\frac{1}{2}$
182	,,	18	Dr.3	4
183	,,	18	Dr.4	$3\frac{1}{2}$
184	,,	18	D. 4	$4\frac{1}{2}$
185	,,	18	Dr.5	4
186	,,	18	Dr.6	$4\frac{1}{4}$
187	,,	18	D. 6	$6\frac{1}{2}$
188	,,	18	Dr.7	7
189	,,	18	Dr.8	7
190	21.3.63	11	Dr.1	6
191	,,	11	D. 1	6
192	,,	11	Dr.2	5
193	,,	10	Dr.3	6
194	,,	10	Dr.4	8

TABLE A.—*continued.*

Station Number.	Date.	Area.	Dive D. Dredge Dr.	Depth (fms).
195	21·3·63	11	D. 2	10½
196	,,	12	Dr.5	11
197	,,	11	D. 3	9
198	,,	12	Dr.6	9
199	,,	6	D. 4	8½
200	,,	6	Dr.7	8
201	22.3.63	2	Dr.1	3½
202	,,	3	Dr.2	2½
203	,,	3	Dr.3	2½
204	,,	7	D. 1	2½
205	,,	7	Dr.4	2½
206	,,	7	Dr.5	4
207	,,	7	D. 2	2½
208	,,	7	Dr.6 ; D. 3	5½
209	,,	13	D. 4	7
210	,,	13	Dr.7	9
211	,,	12	Dr.8	11
212	,,	11	Dr.9	8
213	3.4.63	59	D. 1	8
214	,,	59	Dr.1	6
215	,,	60	D. 1	6
216	,,	67	Dr.1	4
217	,,	67	D. 1	3½
218	,,	68	Dr.1	5
219	,,	68	Dr.3	6¾
220	,,	68	Dr.4	7½
221	,,	69	Dr.1	4
222	,,	69	Dr.2	5
223	4.4.63	58	D. 1	2
224	,,	59	Dr.1	9
225	,,	59	Dr.2	8¾
226	,,	59	Dr.3	8
227	,,	59	D. 2	8
228	,,	50	Dr.1	3½
229	,,	50	Dr.2	2½
230	,,	50	Dr.3	3
231	,,	50	Dr.4	2
232	,,	50	Dr.5	2
233	,,	50	D. 3	2
234	,,	59	Dr.6	8
235	,,	60	Dr.7	8

TABLE A.—*continued.*

Station Number.	Date.	Area.	Dive Dredge D. Dr.	Depth (fms).
236	5.4.63	49	Dr.1	½
237	,,	49	Dr.2	½
238	,,	50	Dr.3	1
239	,,	61	D. 1	4
240	,,	61	Dr.4 ; D. 2	2
241	,,	61	Dr.5	7½
242	,,	61	D. 3	11
243	,,	62	D. 4	11
244	,,	62	Dr.6	9½
245	,,	63	D. 5	9
246	,,	63	Dr.7	8½
247	,,	63	D. 6	7
248	,,	63	D. 7	4½
249	,,	63	D. 8	4½
250	30.4.63	51	Dr.1	3½
251	,,	43	Dr.1	10½
252	1.5.63	52	Dr.1 ; D. 1	13
253	,,	53	Dr.1	12
254	,,	54	Dr.1 ; Dr.2	10
255	,,	55	D. 1	6
256	,,	55	D. 2	4
257	,,	48	D. 1	4
258	,,	47	Dr.1	8½
259	,,	47	Dr.2	10½
260	,,	46	Dr.1	11
261	,,	45	Dr.1	13
262	,,	44	Dr.1	13
263	,,	43	Dr.1	9
264	2.5.63	42	Dr.1	4
265	,,	42	Dr.2	3½
266	,,	50	Dr.3	2½
267	,,	50	Dr.4	2½
268	,,	60	Dr.1	1½
269	,,	60	D. 1	1½
270	,,	51	Dr.1	5
271	,,	51	D. 1	6
272	,,	43	Dr.1	6
273	,,	31	Dr.1	8
274	3.5.63	43	D. 1	6
275	,,	31	D. 1	3
276	,,	31	D. 2	8

TABLE A.—*continued.*

Station Number	Date	Area	Dive D. Dredge Dr	Depth (Fms)
277	3.5.63	32	D. 1	13
278	,,	30	Dr.1	8
279	,,	30	Dr.2	7
280	,,	30	D. 1	1½
281	5.5.63	42	D. 1	2
282	14.5.63	16	D. 1	5
283	,,	16	D. 2	2¼
284	,,	27	Dr.1	1½
285	,,	28	Dr.1	3
286	,,	28	Dr.2	5
287	,,	29	Dr.1	5½
288	,,	42	Dr.1	2
289	,,	42	Dr.2	2
290	15.5.63	58	Dr.1	7
291	,,	66	Dr.1	10
292	,,	66	D. 1	10
293	,,	58	D. 1	6
294	,,	57	Dr.1	10
295	,,	56	D. 1	3
296	16.5.63	37	D. 1	2
297	,,	37	Dr.1	1¼
298	,,	37	Dr.2	4¼
299	,,	25	Dr.1	5
300	,,	26	D. 1	3
301	,,	26	Dr.1	2½
302	,,	27	Dr.1	4
303	17.5.63	43	D. 1	3½
304	,,	19	Dr.1	7
305	,,	19	Dr.2	9
306	,,	19	D. 1	9
307	,,	18	Dr.1	6
308	,,	18	Dr.2	6
309	,,	20	Dr.1	11
310	,,	31	Dr.1	4½
311	19.5.63	38	Dr.1	4
312	,,	39	Dr.1	4
313	,,	39	Dr.2 ; Dr.3	1½
314	,,	39	D. 1	4½
315	,,	28	Dr.1	5
316	,,	28	Dr.2	6
317	,,	29	Dr.3	4½

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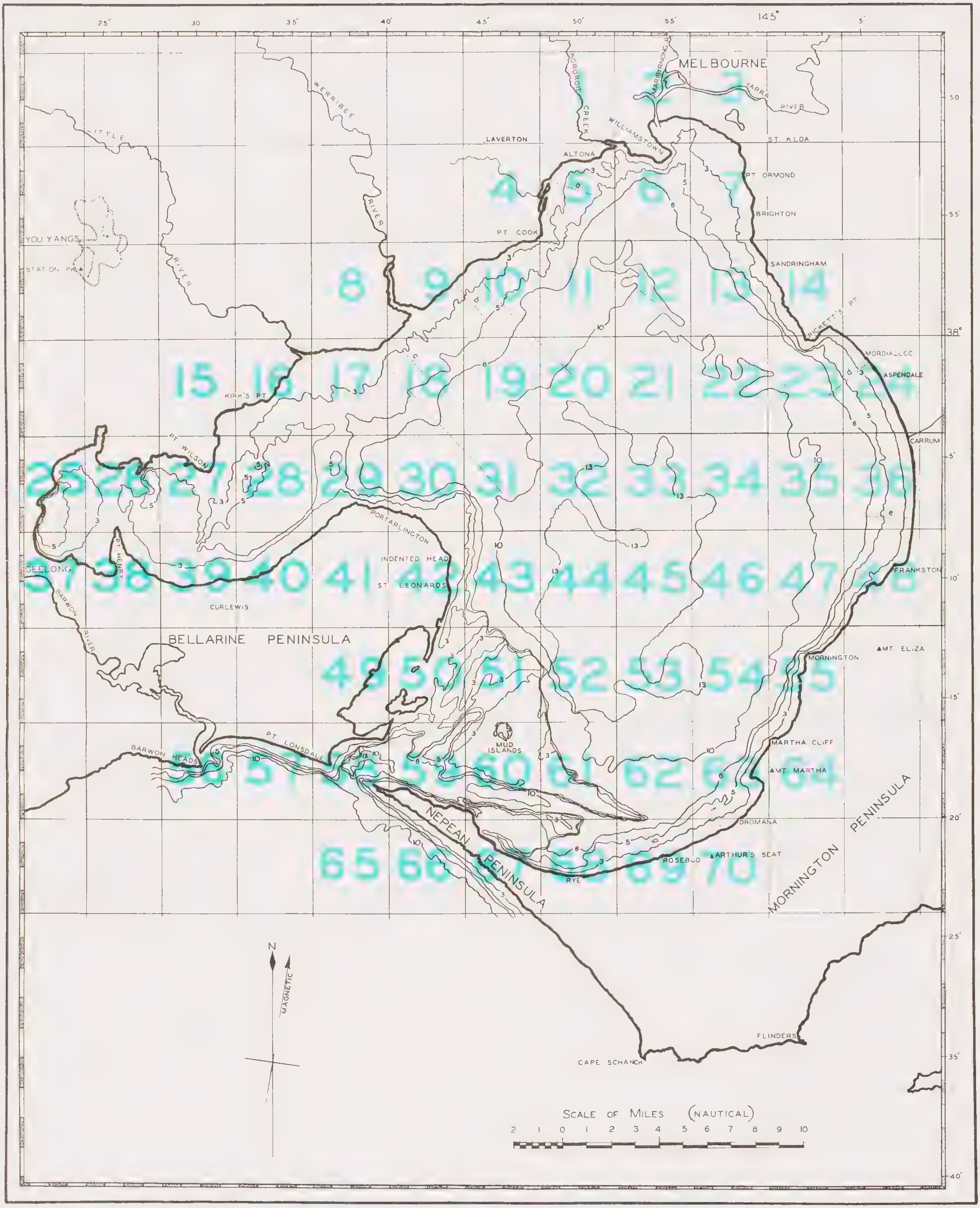

Chart 1.—Bathymetric Chart of Port Phillip Bay showing the 3, 5, 6, 10 and 13 fathom contour-lines.

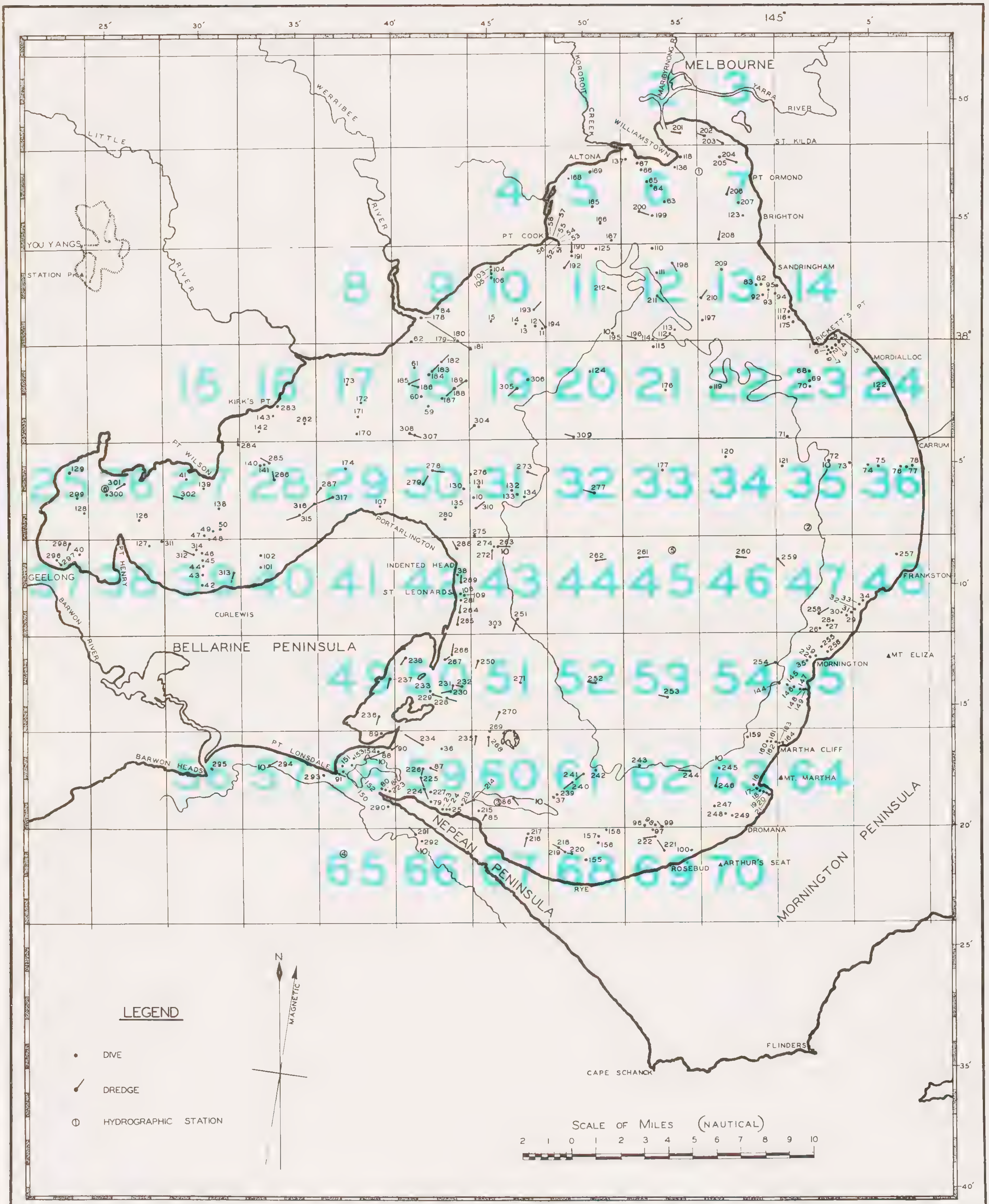

Chart 2.—Port Phillip showing sampling stations and positions of hydrographic stations.

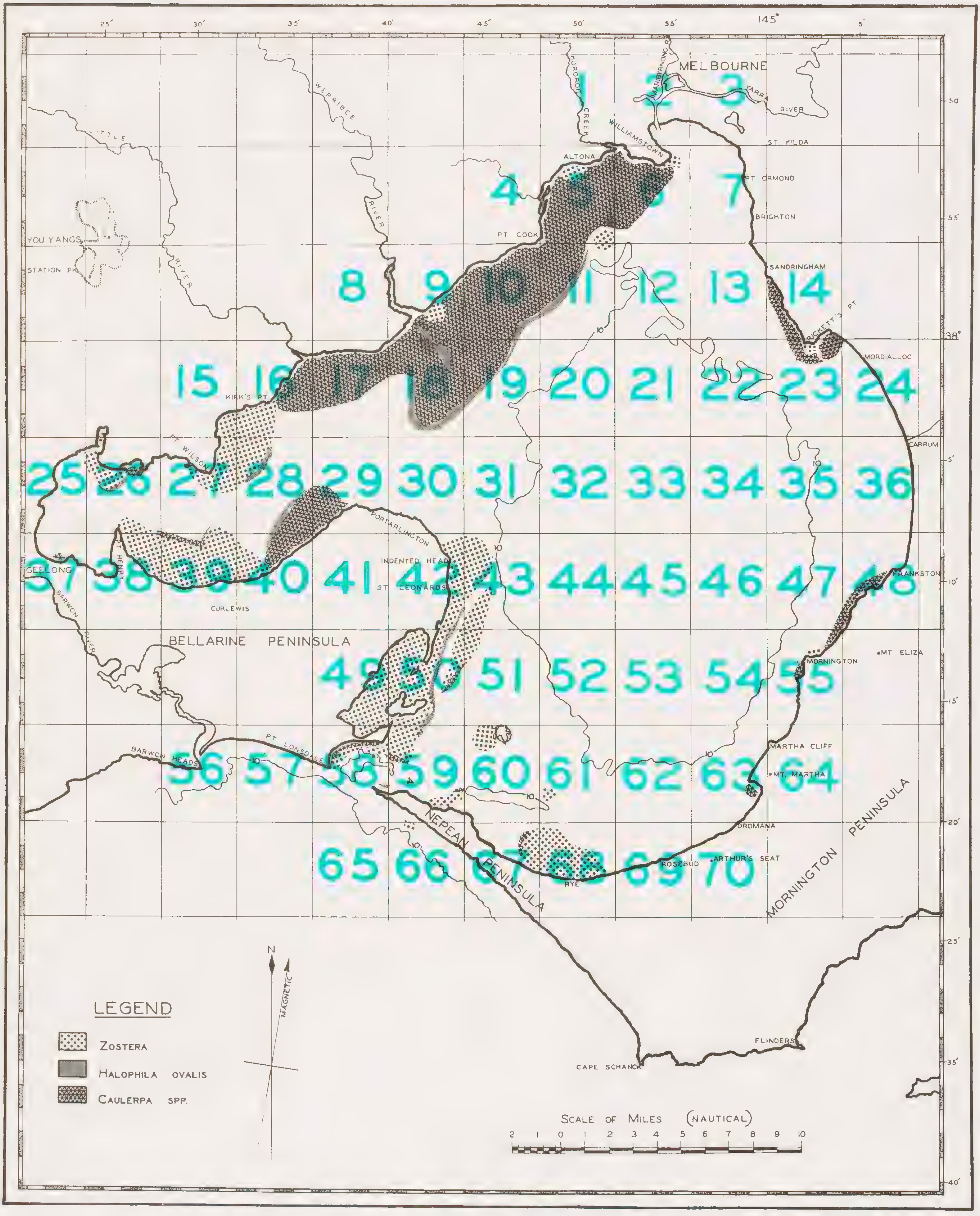

Chart 3—Distribution of Angiosperms and Caulerpa spp.